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Harmonization of the Core Curriculum for Pharmacy Education and Enhancement of the Internationalization Process

Comparative Analysis Report

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Executive Summary

This comparative report under Erasmus+ KA220-HED (WP2) consolidates pharmacy curricula from twelve European universities. It identifies common strengths in foundational sciences and quantifies the diversity of elective offerings, informing strategic actions to harmonize core training while enhancing mobility and specialization opportunities across the consortium.

1. Introduction

Pharmacy is considered a regulated profession in the European Union, which means that certain education and training requirements must be met before a graduate is allowed to practice as a pharmacist. These regulations are contained in the EU Directive 2005/36/EC and its amendments (Directive 2013/55/EU), which set minimum training standards and the mutual recognition of qualifications in EU member states. The harmonization of pharmacy education supports quality, safety and workforce mobility in the EU. This report supports the alignment of core curricula and provides evidence for structured mobility packages.

Key Provisions of EU Directive 2005/36/EC for Pharmacists

1. **Minimum Duration of Studies:**

Pharmacy education must last at least five years, including at least four years of academic training and at least six months of practical training in a pharmacy.

2. **Practical Training Requirements:**

The directive requires a minimum six-month supervised placement in a community or hospital pharmacy to ensure that students gain practical experience before qualifying as a pharmacist. The focus should remain on patient-centered pharmacy practice.

3. **Core Competencies Required for Pharmacists:**

The training must cover:

- The preparation, control, and dispensing of medicines.
- Advising patients on the proper use of medications.
- Pharmacovigilance, drug safety, and clinical decision-making.
- Ethical and legal responsibilities of pharmacists.
- Public health and disease prevention.

4. **Recognition of Professional Qualifications Across EU Countries:**

- Graduates who have completed an accredited pharmacy program in an EU country can have their qualifications recognized in other EU member states according to the principle of mutual recognition.
- Pharmacists must meet the language and licensing requirements of the host country before they are allowed to practice.

2. Methodology

The methodology for this comparative analysis was designed to provide a comprehensive and structured approach to examining the pharmacy curricula from twelve European universities of pharmacy: Valencia, Coimbra, Bratislava, Sofia, Pisa, Bologna, Ferrara, Perugia, Milan, Rome, Padua, and Naples. Together, these institutions represent diverse national traditions yet converge on the shared goal of harmonising pharmacy curricula within the framework of the EU Directive 2005/36/EC.

The goal was to identify similarities and differences that allow opportunities for enhanced internationalization and student mobility.

1.1. Data Collection Process

The analysis was conducted using the following sources:

1. Official Curriculum Documents:
    - Study plans and course lists from each institution were reviewed to compare subject distribution, credit allocation, and learning objectives.
2. European and International Guidelines:
    - The European Higher Education Area (EHEA) standards, the International Pharmaceutical Federation (FIP) educational framework, and EU Directive 2005/36/EC on the Recognition of Professional Qualifications were consulted to assess compliance and alignment.

1.2. Comparative Framework

To ensure consistency and objectivity, a comparative framework was developed, focusing on key educational components:

1.2.1. Course Distribution and Subject Categorization

Each university's curriculum was divided into four main categories:

1. **Basic Sciences:** Chemistry, Biology, Physics, Mathematics, Statistics, Biophysics
2. **Pharmaceutical Sciences:** Pharmaceutical Chemistry, Pharmaceutical Technology, Biopharmacy, Pharmacokintetics, Drug Quality control
3. **Biomedical and Clinical Sciences:** Anatomy, Physiology, Pathophysiology, Microbiology, Immunology, Pharmacology, and Toxicology, Pharmacotherapy & Clinical Pharmacy, Toxicology, Clinical Biochemistry
4. **Pharmacy Practice and Professional Courses:** Social Pharmacy, Pharmaceutical Ethics and Pharmaceutical Legislation, Pharmaceutical Care & Patient Safety, Public Health & Pharmacoepidemiology

These categories allowed for a direct comparison of subject content and distribution across the programs.

1.2.2. ECTS Credit Allocation

The number of European Credit Transfer System (ECTS) credits assigned to each category was analyzed to determine:

- The proportion of core subjects vs. elective courses.
- Differences in workload and academic expectations. A

special focus was placed on comparing:

- Total ECTS per course group/category.
- Elective course flexibility.

1.2.3. Elective Course Availability and Specialization

Electives provide students with opportunities for academic specialization. The comparison assessed:

- The total number of elective subjects available.
- Areas of specialization (e.g. industrial pharmacy, clinical pharmacy, biotechnology, regulatory affairs, alternative medicine).
- The ECTS weight of electives and how they contribute to degree completion.

1.2.4. Internationalization and Student Mobility

The study reviewed internationalization efforts, particularly:

- Availability of English-taught courses.
- Partnerships for student exchanges (Erasmus+, bilateral agreements).

1.3. Data Analysis and Interpretation

The collected data was systematically analyzed using quantitative and qualitative methods:

- Quantitative Analysis:
  - Credit allocation comparisons were made using tabular representations to visualize differences.
  - Elective availability and specialization options were assessed using numerical breakdowns.
- Qualitative Analysis:
  - Descriptive comparisons highlighted curriculum strengths and gaps.
  - Stakeholder feedback provided insights into the effectiveness of each program's structure.
  - Best practices were identified for potential curriculum enhancements.

1.4. Limitations of the analysis

While this methodology ensures a robust comparative analysis, some limitations exist:

- Differences in national education policies may influence curriculum design beyond institutional control.
- Availability of elective courses may change annually, affecting direct comparability.
- Institutional autonomy in assessment methods and learning outcomes could impact curriculum alignment.

Despite these limitations, the comparative framework provides valuable insights for enhancing pharmacy education alignment and supporting student mobility between institutions.

3. Global Analysis of the Curricula

3.1 General Structure of the Curricula

All twelve partner universities implement integrated five-year Master programmes in Pharmacy (≈300 ECTS), in line with EU Directive 2005/36/EC.
Despite this structural homogeneity, two curricular patterns emerge:

- **Chemistry–biology intensive track** (Valencia, Milan, Pisa). These programmes emphasise chemistry, biochemistry, and molecular sciences during the first two years, postponing pharmaceutics and therapeutics to Years 3–4.
- **Early biomedical exposure track** (Coimbra, Bologna). These curricula integrate anatomy, physiology, pathology, and public health earlier, balancing them with laboratory foundations.

Laboratory training is systematically embedded in Years 1–3, while professional/clinical immersion (community pharmacy, hospital pharmacy, clinical rotations) is concentrated in Year 5.

Italian partners (e.g., Bologna, Naples, Padua, Rome) typically devote more credits to Professional/Regulatory subjects, while Eastern partners (e.g., Bratislava, Sofia) present leaner allocations.

Thus, although pathways differ, final outcomes converge on comparable graduate profiles, enabling recognition across the consortium.

3.2 Distribution of ECTS across Subject Areas

The following table shows the absolute ECTS by subject area and university:

University	Basic	Pharmaceutical	Biomedical/Clinical	Professional/Regulatory	Total
University of Valencia	96.0	82.0	84.0	32.0	294.0
University of Coimbra	88.0	90.0	82.0	30.0	290.0
Comenius University Bratislava	92.0	76.0	78.0	28.0	274.0
Medical University Sofia	84.0	74.0	80.0	26.0	264.0
University of Pisa	94.0	98.0	86.0	34.0	312.0
University of Bologna	90.0	92.0	88.0	30.0	300.0
University of Ferrara	86.0	84.0	80.0	28.0	278.0
University of Perugia	88.0	80.0	78.0	26.0	272.0
University of Milan	100.0	96.0	90.0	36.0	322.0

University of Rome	92.0	94.0	92.0	34.0	312.0
University of Padua	94.0	92.0	88.0	32.0	306.0
University of Naples	96.0	98.0	90.0	34.0	318.0

(values in ECTS; extracted from the each study plan)

- **Basic Sciences** are consistently strong (≈25–35% of credits).
- **Pharmaceutical Sciences** vary: Pisa, Naples, Milan >95 ECTS; Sofia, Bratislava <80 ECTS.
- **Biomedical/Clinical Sciences** dominate late years; Rome, Milan peak at >90 ECTS.
- **Professional/Regulatory** diverges most: Italian partners ≥32 ECTS vs Eastern partners ~26–28 ECTS.

3.3 Timing of Electives

Electives are the main lever for curricular flexibility and mobility.
The table below summarises the elective offer across partners:

University	Courses (n)	Electives (n)	Electives ECTS	Electives %
University of Valencia	145	24	54.0	18.4%
University of Coimbra	132	10	26.0	9.0%
Comenius University Bratislava	128	12	28.0	10.2%
Medical University Sofia	120	8	14.0	5.3%
University of Pisa	150	22	52.0	16.7%
University of Bologna	148	25	60.0	20.0%
University of Ferrara	130	14	30.0	10.8%
University of Perugia	126	9	18.0	6.6%

University of Milan	152	20	48.0	14.9%
University of Rome	140	18	44.0	14.1%
University of Padua	144	19	42.0	13.7%
University of Naples	150	23	50.0	15.7%

- **Bologna, Valencia, Naples**: electives ≥20% of curriculum → strong inbound mobility potential.
- **Sofia, Perugia, Coimbra**: electives ≤10% → limited flexibility, more challenging for exchange.
- **Milan, Rome, Padua**: moderate elective capacity (13–15%), supporting both short and long exchanges.

3.4 Mobility Windows

Optimal mobility windows are concentrated in Semesters 7–8 and 9–10, when elective density is highest.
This allows inbound students to select electives without displacing core modules.

- Favourable contexts: Bologna (Semester 7 with many electives), Valencia and Naples (Semester 9–10 with large elective menus).
- Challenging contexts: Perugia and Sofia (compulsory courses distributed across all semesters). For these, micro-windows anchored in professional rotations + targeted electives are recommended.

Strategic Recommendations

1. Publish a consortium-wide elective catalogue with semester codes and ECTS.
2. Map electives to a shared outcomes grid for ex-ante recognition.
3. Align academic calendars (±2 weeks) to minimise conflicts.
4. Develop mobility tracks (e.g., *Clinical & Therapeutics* in Rome/Milan; *Pharmaceutics & Technology* in Pisa/Naples/Bologna).

4. Analysis of Subject Areas

4.1 Basic Sciences

Central role of Basic Sciences.
Basic Sciences form the intellectual foundation of pharmacy curricula. They encompass mathematics, physics, chemistry, biology, biochemistry, botany, microbiology, and related laboratory disciplines. Across the twelve universities, the allocation ranges between 84 and 100 ECTS, representing approximately 30–33% of the total curriculum. This indicates a broad consensus within the consortium: a solid grounding in the natural sciences is indispensable for the development of pharmaceutical expertise.

Convergence across institutions.
The relative uniformity of Basic Science allocations demonstrates convergence with European standards and reflects the requirements of Directive 2005/36/EC, which emphasises the mastery of fundamental sciences. Minor variations can be attributed to institutional traditions and pedagogical philosophies. For instance, Milan (100 ECTS) and Valencia (96 ECTS) prioritise extensive laboratory practice and analytical chemistry, while Sofia (84 ECTS) maintains a more compact block, integrating biomedical subjects earlier in the curriculum.

Implications for harmonisation.
The convergence in Basic Sciences provides a solid platform for mobility during Years 1–2. Students can transfer across institutions with confidence that credits earned in chemistry, biology, and related laboratory courses will be recognised. This creates opportunities for early-stage exchanges, which are typically more difficult to implement due to curricular rigidity. By mapping equivalences explicitly, the consortium can unlock short-term mobility windows in foundational sciences.

Balance with later stages.
While Basic Sciences are critical, the balance between foundational and applied content determines the distinct identity of each programme. Institutions with higher allocations (Bratislava, Milan, Valencia) produce graduates with very strong scientific literacy, well-prepared for research or industrial contexts. Those with slightly lower allocations (Sofia, Rome) may integrate biomedical and clinical elements earlier, orienting students more directly toward patient-centred practice. Both strategies converge by graduation, but the timing of exposure influences student perception of the discipline and shapes early professional identity.

Table B-1. ECTS allocation to Basic Sciences by University

University	Basic Sciences ECTS	Share of total curriculum (%)
University of Valencia	96.0	32.7%

University of Coimbra	88.0	30.3%
Comenius University Bratislava	92.0	33.6%
Medical University Sofia	84.0	31.8%
University of Pisa	94.0	30.1%
University of Bologna	90.0	30.0%
University of Ferrara	86.0	30.9%
University of Perugia	88.0	32.4%
University of Milan	100.0	31.1%
University of Rome	92.0	29.5%
University of Padua	94.0	30.7%
University of Naples	96.0	30.2%

Strategic recommendations.

1. **Codify equivalences**: Develop a shared recognition matrix of Basic Science modules across the consortium, facilitating automatic transfer of credits.
2. **Promote early exchanges**: Encourage short-term mobility (e.g., summer laboratory placements) during Years 1–2, building trust and engagement before professional specialisation.
3. **Strengthen transversal skills**: Integrate data analysis, statistics, and informatics within the Basic Science block to align with the digitalisation of pharmaceutical research.
4. **Support diversity of emphasis**: While convergence is desirable, institutional differences (e.g., more chemistry vs. more biology) should be leveraged as unique selling points for inbound mobility.

4.2 Pharmaceutical Sciences

Scope and position in the curriculum.
Pharmaceutical Sciences anchor the professional identity of Pharmacy programmes by integrating pharmaceutics, biopharmaceutics, drug delivery, medicinal chemistry, pharmacognosy, toxicology, and industrial pharmacy/technology. Across the consortium, allocations range from 74.0 to 98.0 ECTS (≈28–31%), signalling a robust and relatively homogeneous commitment. Compared with Basic Sciences, dispersion is wider here, reflecting national traditions and the research/industry ecosystems surrounding each faculty.

Profiles and emphases.
A technology-intensive profile is evident in Pisa (98.0), Naples (98.0), Milan (96.0), Rome (94.0), Bologna (92.0), and Padua (92.0), where pharmaceutics, process engineering, quality systems, and dosage-form design occupy a prominent share. These nodes often host strong industrial pharmacy strands, aligning with regional pharma clusters and GMP-oriented facilities. Conversely, Bratislava (76.0) and Sofia (74.0) adopt a leaner technology footprint, rebalancing attention towards pharmacology/therapeutics earlier in the trajectory (captured in the Biomedical/Clinical family), while

keeping Pharmaceutical Sciences compact and focused. Coimbra (90.0) sits at the upper range, with an emphasis on medicinal chemistry and pharmaceutical technology integrated from mid-programme.

Articulation with Basic and Clinical blocks.
Where Basic Sciences are stronger (e.g., Milan, Valencia), Pharmaceutical Sciences tend to leverage that foundation to accelerate advanced formulation science and analytical quality control by Year 3–4. In programmes with early biomedical exposure (Coimbra, Bologna), pharmaceutics is sequenced in tandem with clinical needs, making room for biopharmaceutics and drug delivery correlated with therapeutic use-cases (e.g., modified-release systems, targeted delivery). This articulation optimises readiness for late clinical immersion while preserving the manufacturing and quality competences expected of graduates.

Laboratories, facilities, and practice interfaces.
The breadth of laboratory-based pharmaceutics (excipients, unit operations, pilot-scale manufacturing, stability and compatibility testing) largely explains the higher ECTS bands in Italy (Pisa, Naples, Bologna, Padua, Rome, Milan). These environments frequently maintain pilot lines, instrumented QC labs, and GMP-like operating procedures, which support capstone projects and industry-embedded dissertations. Where this footprint is leaner (Sofia, Bratislava), students typically rely on shared or central facilities, focusing on core formulation principles and quality concepts rather than full process engineering depth.

Implications for mobility and recognition.
The relative homogeneity of shares (≈28–31%) makes cross-recognition feasible. Still, module granularity varies: some partners package pharmaceutics into larger integrated modules (10–12 ECTS), while others split content into smaller components (4–6 ECTS) — important for Learning Agreement design. Mobility is most fluid when incoming students can select coherent clusters (e.g., *Formulation I + Biopharmaceutics + QC*), ensuring both content continuity and assessment alignment.

Competence profile and graduate outcomes.
High allocations correlate with graduates exhibiting strong formulation design skills, regulatory-aware quality mindset, and industry readiness (tech transfer, scale-up, validation). Balanced programmes that coordinate pharmaceutics with therapeutics foster translational literacy: understanding how dosage-form properties shape exposure–response and patient outcomes, a competence increasingly valued across hospital and community settings.

Table B-2. ECTS allocation to Pharmaceutical Sciences by University

University	Pharmaceutical Sciences ECTS	Share of total curriculum (%)
University of Valencia	82.0	27.9%
University of Coimbra	90.0	31.0%
Comenius University Bratislava	76.0	27.7%

Medical University Sofia	74.0	28.0%
University of Pisa	98.0	31.4%
University of Bologna	92.0	30.7%
University of Ferrara	84.0	30.2%
University of Perugia	80.0	29.4%
University of Milan	96.0	29.8%
University of Rome	94.0	30.1%
University of Padua	92.0	30.1%
University of Naples	98.0	30.8%

(Shares computed against the total listed ECTS per institution.)

Illustrative Electives and Area Compatibilities (Pharmaceutical Sciences)

Representative elective families frequently observed in the consortium's catalogues (red-coded in the spreadsheet):

- **Advanced Drug Delivery & Biomaterials** (nano-/micro-carriers, targeted delivery, mucosal/ocular/dermal systems)
- **Pharmaceutical Biotechnology** (biologics formulation, stability of proteins/peptides)
- **Quality by Design (QbD) & Process Analytical Technology (PAT)**
- **Regulatory CMC & Pharmaceutical Quality Systems**
- **Industrial Pharmacy & Scale-up** (continuous manufacturing, validation, tech transfer)
- **Cosmetology & Dermopharmacy** (formulation and safety assessment)
- **Herbal Medicines & Pharmacognosy** (standardization, phytochemical QC)

High-compatibility pairings across areas (for mobility tracks):

- *Pharmaceutical Sciences* + **Basic Sciences → Medicinal Chemistry + Analytical Quality Control** (spectroscopy/LC-MS methods; impurity profiling)
- *Pharmaceutical Sciences* + **Biomedical/Clinical → Biopharmaceutics + Clinical Pharmacokinetics** (exposure–response, dose individualisation)
- *Pharmaceutical Sciences* + **Professional/Regulatory → CMC/Regulatory Affairs** (dossiers, stability, variations, GMP compliance)

These combinations are ideal to design **mobility tracks** (18–24 ECTS) that remain **coherent** y facilitan el **reconocimiento ex-ante**.

Strategic Recommendations

1. Publish elective clusters (3–4 modules semestrales) etiquetados por Formulation/Industrial, Biopharmaceutics/PK, Regulatory CMC/QMS, para que los estudiantes inbound puedan construir rutas compactas y coherentes (18–24 ECTS).

2. Adopt a shared outcomes grid para Pharmaceutical Sciences (formulation design, material science, biopharmaceutics, QC, regulatory literacy) con rúbricas comunes de evidencias (protocolos, informes de estabilidad, diseños DoE), agilizando la convalidación.
3. Synchronise assessment windows (±2 semanas) y formatos (report-plus-viva) en los semestres con mayor densidad de optativas para minimizar fricciones.
4. Strengthen translational bridges con Biomedical/Clinical: ofertar parejas Biopharmaceutics + Clinical PK o Drug Delivery + Therapeutics que articulen ciencia de formulación con resultados clínicos.
5. Industry-embedded options: ampliar prácticas/capstones co-supervisadas por empresa en las sedes con pilot lines (Pisa, Naples, Bologna, Padua, Rome, Milan), compartiendo plazas con socios con menor huella industrial (Bratislava, Sofia).

4.3 Biomedical/Clinical Sciences

Centrality of Biomedical/Clinical Sciences.
Biomedical and Clinical Sciences embody the translational core of pharmacy education, bridging foundational science with patient-centred practice. These subjects cover anatomy, physiology, pathology, immunology, genetics, microbiology (applied), pharmacology, clinical pharmacotherapy, toxicology (applied), public health, nutrition, and clinical rotations.

Across the consortium, allocations range from 78 to 92 ECTS, representing about 28–30% of the total programme. The narrow band of percentages underscores the strategic consensus: clinical and biomedical competences are indispensable for the graduate pharmacist profile.

Comparative emphasis.

- High allocations: Rome (92.0), Milan (90.0), Naples (90.0). These universities strengthen clinical pharmacotherapy, pharmacokinetics, and therapeutic decision-making, embedding clinical exposure early in Years 3–4.
- Moderate allocations: Bologna (88.0), Padua (88.0), Pisa (86.0). These curricula emphasise biomedical integration with pharmaceutical sciences, balancing technology with applied therapeutics.
- Lean allocations: Bratislava (78.0), Perugia (78.0). Although absolute ECTS remain substantial, biomedical content is streamlined, often compensated by heavier emphasis on basic or pharmaceutical sciences.
- Eastern partners (Sofia 80.0, Bratislava 78.0) tend to prioritise pharmacology and public health, with less modular depth in advanced clinical pharmacotherapy compared to Italian institutions.

Sequencing and integration.
Biomedical/Clinical subjects typically escalate in Years 3–5. A common pattern is:

- Years 1–2: Anatomy, Physiology, General Pathology.
- Years 3–4: Pharmacology, Toxicology, Microbiology (applied), Immunology.
- Year 5: Clinical Pharmacy, Pharmacotherapy, Hospital/Community Rotations.

This sequencing ensures a progressive scaffolding of competences from cellular physiology to therapeutic decision-making. Institutions like Milan and Rome reinforce integration through clinical case seminars and joint teaching with medical faculties, while Bologna and Coimbra embed public health and epidemiology modules earlier.

Implications for harmonisation.
Given the strong convergence (≈28–30% across all partners), Biomedical/Clinical Sciences are an ideal domain for mobility in advanced years. Exchange students can reliably transfer credits in Pharmacology, Clinical Pharmacy, and Pharmacotherapy. Nevertheless, variability in module size (large integrated courses vs. smaller thematic units) requires explicit mapping in Learning Agreements.

Strengths and challenges.

- Strengths: Ensures pharmacists graduate with competencies in rational medicine use, therapeutic monitoring, pharmacovigilance, and patient-centred care. Facilitates inter-professional collaboration with medicine and nursing.
- Challenges: Alignment of clinical exposure opportunities (hospital/community pharmacy practice) varies greatly. Some universities offer structured rotations (Italy, Coimbra), while others limit exposure due to regulatory constraints (Sofia, Bratislava).

Table B-3. ECTS allocation to Biomedical/Clinical Sciences by university

University	Biomedical/Clinical ECTS	Share of total curriculum (%)
University of Valencia	84.0	28.6%
University of Coimbra	82.0	28.3%
Comenius University Bratislava	78.0	28.5%
Medical University Sofia	80.0	30.3%
University of Pisa	86.0	27.6%
University of Bologna	88.0	29.3%
University of Ferrara	80.0	28.8%
University of Perugia	78.0	28.7%
University of Milan	90.0	28.0%
University of Rome	92.0	29.5%
University of Padua	88.0	28.8%
University of Naples	90.0	28.3%

Illustrative Electives and Compatibilities (Biomedical/Clinical Sciences)

Representative electives (from red-coded courses in the spreadsheet and partner catalogues):

- Advanced Clinical Pharmacotherapy (oncology, cardiology, CNS disorders).
- Clinical Nutrition and Dietetics.
- Pharmacogenomics & Personalised Medicine.

- Public Health & Epidemiology of Medicines.
- Immunopharmacology & Biologics.
- Pharmacovigilance & Risk Management.

High-compatibility pairings across areas:

- *Biomedical/Clinical* + Basic Sciences → Pharmacogenomics + Molecular Biology (bridging laboratory science with personalised therapy).
- *Biomedical/Clinical* + Pharmaceutical Sciences → Clinical PK + Biopharmaceutics (dose individualisation, exposure–response relationships).
- *Biomedical/Clinical* + Professional/Regulatory → Pharmacovigilance + Regulatory Risk Assessment (patient safety + EMA/FDA frameworks).

These combinations provide natural mobility tracks (18–24 ECTS), aligning clinical skills with scientific and regulatory perspectives.

Strategic Recommendations

1. Map common core outcomes in Pharmacology, Pharmacotherapy, Public Health, ensuring automatic recognition of ≥60% of Biomedical/Clinical modules across the consortium.
2. Expand elective catalogues in advanced therapeutics (oncology, infectious disease, precision medicine) to leverage institutional strengths and attract inbound students.
3. Synchronise clinical practice opportunities, defining minimum exposure standards (e.g., 6 ECTS hospital/community rotations) for harmonisation.
4. Promote translational bridges with Pharmaceutical Sciences (joint modules Biopharmaceutics + Clinical PK) to strengthen exposure–response literacy.
5. Embed inter-professional training: shared seminars with medical/nursing faculties to enhance team-based care competences.

4.4 Professional/Regulatory Sciences

Defining the professional/regulatory domain.
This area encompasses courses in pharmacy law, ethics and deontology, pharmaceutical legislation, regulatory frameworks (EU/FDA), management, economics, communication, and professional practice (community/hospital pharmacy). While the total ECTS allocated is lower compared to other domains, these modules shape the professional identity of pharmacists and ensure compliance with national and European standards for licensure and practice.

Comparative emphasis.
Allocations range from 26.0 to 36.0 ECTS (≈9.6–11.2% of the total curriculum). The most substantial weights are observed in Milan (36.0), Pisa (34.0), Rome (34.0), and Naples (34.0), reflecting strong traditions in professional regulation, law, and deontology. Eastern partners (Sofia 26.0, Perugia 26.0,

Bratislava 28.0) operate at the lower bound, providing the essentials but with fewer specialised modules in management, policy, or economics.

Integration with professional practice.
These subjects typically culminate in practice-based experiences, particularly in community and hospital pharmacy placements (Year 5). Italian institutions generally integrate pharmacy law and deontology with capstone practice rotations, ensuring that students graduate with a strong awareness of both professional ethics and regulatory compliance. Other partners, like Sofia and Bratislava, maintain a leaner law/ethics curriculum, supplemented by compulsory professional practice but with less formal coursework in management or economics.

Implications for mobility and harmonisation.
Professional/Regulatory modules pose specific challenges for mobility:

- They are often country-specific (national law, pharmacy practice regulations).
- Recognition across borders requires careful mapping to European-level frameworks (e.g., EMA, Directive 2005/36/EC).

Nevertheless, the shared EU context provides sufficient common ground in Good Pharmacy Practice (GPP), regulatory science, and ethics/deontology to enable recognition of a significant portion of credits. Where purely national content exists (e.g., local legislation), universities can design mobility-compatible electives focused on EU regulatory science, ethics, and global policy to facilitate inbound exchanges.

Table B-4. ECTS allocation to Professional/Regulatory Sciences by university

University	Professional/Regulatory ECTS	Share of total curriculum (%)
University of Valencia	32.0	10.9%
University of Coimbra	30.0	10.3%
Comenius University Bratislava	28.0	10.2%
Medical University Sofia	26.0	9.8%
University of Pisa	34.0	10.9%
University of Bologna	30.0	10.0%
University of Ferrara	28.0	10.1%
University of Perugia	26.0	9.6%
University of Milan	36.0	11.2%
University of Rome	34.0	10.9%
University of Padua	32.0	10.5%
University of Naples	34.0	10.7%

Illustrative Electives and Compatibilities (Professional/Regulatory Sciences)

Representative electives

- EU and International Regulatory Affairs (EMA, ICH, FDA harmonisation).
- Pharmacy Ethics & Professional Deontology.
- Health Economics and Pharmacoeconomics.
- Pharmacy Management & Leadership.
- Patient Communication and Counselling.
- Pharmaceutical Marketing & Market Access.

High-compatibility pairings across areas

- *Professional/Regulatory* + Pharmaceutical Sciences → CMC Regulatory Affairs + Quality Systems.
- *Professional/Regulatory* + Biomedical/Clinical → Pharmacovigilance + Risk Management Frameworks.
- *Professional/Regulatory* + Basic Sciences → Pharmaceutical Law + Laboratory Safety & Quality Standards.

These pairings can create mobility tracks (12–18 ECTS) anchored in regulatory science, ethics, and patient care, attractive for students seeking EU/global perspectives.

Strategic Recommendations

1. Develop a shared elective catalogue in Professional/Regulatory Sciences centred on EU and international frameworks, ensuring cross-border recognition.
2. Embed minimum standards: agree on a baseline of 30 ECTS consortium-wide, covering ethics, deontology, law, communication, and practice.
3. Leverage diversity: Italian partners' stronger emphasis on law/ethics can host students needing reinforcement in these areas; Eastern partners' more concise curricula allow inbound students to complement with electives.
4. Create joint modules with industry and regulatory agencies (EMA, national authorities) to provide practical exposure to dossier submission, pharmacovigilance, and compliance.
5. Promote inter-professional modules combining management, communication, and patient counselling, reinforcing the pharmacist's role as a healthcare provider.

5. Comparative Overview by University

5.1 University of Valencia

The University of Valencia displays a balanced curriculum with strong emphasis on Basic Sciences (96.0 ECTS) and Biomedical/Clinical Sciences (84.0 ECTS). Pharmaceutical Sciences (82.0) are robust but slightly leaner compared to Italian peers. A defining feature is the large elective portfolio (18.4%), concentrated in Years 4–5, which supports high mobility potential.
Strengths include: well-structured laboratory foundation, diverse electives, and strong integration with Biomedical/Clinical areas. Challenges: slightly lower Pharmaceutical allocation compared with industrially oriented universities. Overall, Valencia is highly attractive for mobility in late years thanks to its elective flexibility.

Table C-1. Key indicators – University of Valencia

Indicator	Value
Total ECTS (listed)	294.0
Total Courses (n)	145
Electives (n)	24
Electives ECTS	54.0
Electives share (%)	18.4%
Basic Sciences	96.0
Pharmaceutical Sciences	82.0
Biomedical/Clinical Sciences	84.0
Professional/Regulatory Sciences	32.0

5.2 University of Coimbra

Coimbra offers a compact and coherent curriculum, close to the 300 ECTS benchmark. Its Pharmaceutical Sciences allocation (90.0) is strong, balanced with Biomedical/Clinical Sciences (82.0). Electives are limited (9.0%), reducing flexibility for mobility, though the programme integrates Biomedical/Clinical subjects earlier than most peers. Strengths: balanced subject distribution, early biomedical exposure. Weakness: limited elective capacity may constrain Erasmus exchanges. Recommended strategy: develop targeted elective windows in Years 4–5 to enhance mobility potential.

Table C-2. Key indicators – University of Coimbra

Indicator	Value
Total ECTS (listed)	290.0
Total Courses (n)	132
Electives (n)	10
Electives ECTS	26.0
Electives share (%)	9.0%
Basic Sciences	88.0
Pharmaceutical Sciences	90.0
Biomedical/Clinical Sciences	82.0
Professional/Regulatory Sciences	30.0

5.3 Comenius University Bratislava

Bratislava shows a strong Basic Sciences block (92.0) but a relatively lean Pharmaceutical Sciences allocation (76.0), reflecting an emphasis on pharmacology and biomedical integration. Elective share

is modest (10.2%), which constrains inbound mobility. Strengths: solid foundational sciences, balanced biomedical allocation. Challenges: lower pharmaceutical technology exposure and fewer electives compared to Western European peers. Strategic opportunities include: aligning electives with Biomedical/Clinical tracks to attract students seeking strong pharmacology grounding.

Table C-3. Key indicators – Comenius University Bratislava

Indicator	Value
Total ECTS (listed)	274.0
Total Courses (n)	128
Electives (n)	12
Electives ECTS	28.0
Electives share (%)	10.2%
Basic Sciences	92.0
Pharmaceutical Sciences	76.0
Biomedical/Clinical Sciences	78.0
Professional/Regulatory Sciences	28.0

5.4 Medical University of Sofia

Sofia runs a compact curriculum (264.0 ECTS listed) with leaner allocations across all subject families. Basic (84.0) and Biomedical/Clinical (80.0) remain substantial, but Pharmaceutical Sciences are lower (74.0). Professional/Regulatory is concise (26.0). Electives are scarce (5.3%), limiting mobility potential. Strengths: efficient curriculum, clear biomedical orientation. Weaknesses: very limited elective space, fewer pharmaceutical technology modules. Strategic recommendations: expand electives in Years 4–5, especially in pharmaceutics and regulatory sciences, to improve attractiveness for mobility.

Table C-4. Key indicators – Medical University Sofia

Indicator	Value
Total ECTS (listed)	264.0
Total Courses (n)	120
Electives (n)	8
Electives ECTS	14.0
Electives share (%)	5.3%
Basic Sciences	84.0
Pharmaceutical Sciences	74.0
Biomedical/Clinical Sciences	80.0
Professional/Regulatory Sciences	26.0

5.5 University of Pisa

Pisa exhibits a technology-forward profile within the consortium. The Pharmaceutical Sciences allocation (98.0 ECTS) is among the highest, supported by strong Basic Sciences (94.0) and a solid Biomedical/Clinical component (86.0). The elective share (16.7%) provides meaningful flexibility in Years 4–5, enabling inbound students to build coherent tracks in formulation science, industrial pharmacy, quality systems (QMS), and CMC. Laboratory infrastructure and pilot-line exposure strengthen industry readiness (scale-up, validation, stability/compatibility).
Strategically, Pisa is well suited for mobility in pharmaceutics/industrial domains and biopharmaceutics–PK bridges with clinical modules. A potential enhancement would be expanding regulatory science and market access electives to complement the strong technological core and ease recognition across systems focused on regulatory outcomes.

Table C-5. Key indicators – University of Pisa

Indicator	Value
Total ECTS (listed)	312.0
Total Courses (n)	150
Electives (n)	22
Electives ECTS	52.0
Electives share (%)	16.7%
Basic Sciences	94.0
Pharmaceutical Sciences	98.0
Biomedical/Clinical Sciences	86.0
Professional/Regulatory Sciences	34.0

5.6 University of Bologna

Bologna combines balanced subject weights with the largest elective capacity in the group (20.0%). The distribution—Basic (90.0), Pharmaceutical (92.0), Biomedical/Clinical (88.0)—supports multiple mobility windows, especially in Semesters 7–10. This allows inbound students to specialise without displacing compulsory modules. The profile is particularly attractive for tracks in drug delivery, biopharmaceutics, clinical PK, and translational therapeutics.
Bologna's elective density eases Learning Agreement design and recognition. A practical recommendation is to maintain clustered elective menus (3–4 modules/semester con horarios coordinados) y publicar cronogramas de evaluación con antelación, consolidando su posicionamiento como hub de movilidad en el consorcio.

Table C-6. Key indicators – University of Bologna

Indicator	Value
Total ECTS (listed)	300.0
Total Courses (n)	148

Electives (n)	25
Electives ECTS	60.0
Electives share (%)	20.0%
Basic Sciences	90.0
Pharmaceutical Sciences	92.0
Biomedical/Clinical Sciences	88.0
Professional/Regulatory Sciences	30.0

5.7 University of Ferrara

Ferrara presents a compact and well-balanced curriculum, with weightings close to the consortium average. Basic (86.0) and Pharmaceutical (84.0) build a solid foundation for technical electives in Years 4–5, while Biomedical/Clinical (80.0) offers a clear pathway toward pharmacotherapy and public health. The elective capacity (10.8%) is moderate: feasible for mobility, though less flexible than in Bologna or Pisa.

A useful strategy is to group electives into thematic blocks (e.g., Formulation & QC / Clinical & Public Health), with coordinated schedules to facilitate timetable alignment for inbound students. Strengthening regulatory/CMC and clinical communication as cross-cutting electives broadens compatibility with the consortium's recognition frameworks.

Table C-7. Key indicators – University of Ferrara

Indicator	Value
Total ECTS (listed)	278.0
Total Courses (n)	130
Electives (n)	14
Electives ECTS	30.0
Electives share (%)	10.8%
Basic Sciences	86.0
Pharmaceutical Sciences	84.0
Biomedical/Clinical Sciences	80.0
Professional/Regulatory Sciences	28.0

5.8 University of Perugia

Perugia operates with a reduced percentage of electives (6.6%), which limits flexibility for mobility. The structure is balanced—Basic (88.0), Pharmaceutical (80.0), Biomedical/Clinical (78.0)—and ensures outcomes comparable to the consortium average; however, the dispersion of compulsory courses across semesters reduces exchange windows.

Key recommendations: (i) enable micro-windows in Semesters 7–10 anchored in professional rotations and 1–2 targeted electives; (ii) increase the elective offering (at least +6–12 ECTS) in Pharmaceutical/Regulatory to create inbound routes of 12–18 ECTS; (iii) publish semester catalogues sufficiently in advance, facilitating ex-ante learning agreements.

Table C-8. Key indicators – University of Perugia

Indicator	Value
Total ECTS (listed)	272.0
Total Courses (n)	126
Electives (n)	9
Electives ECTS	18.0
Electives share (%)	6.6%
Basic Sciences	88.0
Pharmaceutical Sciences	80.0
Biomedical/Clinical Sciences	78.0
Professional/Regulatory Sciences	26.0

5.9 University of Milan

Milan presents one of the largest curricula (322.0 ECTS), with Basic Sciences (100.0) and Pharmaceutical Sciences (96.0) at the upper range, reflecting a science-intensive identity. Biomedical/Clinical is also high (90.0), complemented by a strong Professional/Regulatory component (36.0). The elective share (14.9%) is sufficient to host inbound mobility, particularly in advanced topics. Strengths: comprehensive subject coverage, strong laboratory base, robust regulatory/ethics strand. Challenges: managing the high total ECTS relative to the European benchmark of 300. Milan is particularly well-positioned to attract students in medicinal chemistry, pharmacotherapy, and professional ethics tracks.

Table C-9. Key indicators – University of Milan

Indicator	Value
Total ECTS (listed)	322.0
Total Courses (n)	152
Electives (n)	20
Electives ECTS	48.0
Electives share (%)	14.9%
Basic Sciences	100.0
Pharmaceutical Sciences	96.0
Biomedical/Clinical Sciences	90.0
Professional/Regulatory Sciences	36.0

5.10 University of Rome

Rome maintains a balanced curriculum across all four domains, with near-equal emphasis on Basic (92.0), Pharmaceutical (94.0), and Biomedical/Clinical (92.0). The Professional/Regulatory allocation (34.0) aligns with Italian peers. Electives (14.1%) provide reasonable mobility flexibility, especially in clinical pharmacotherapy, pharmacovigilance, and regulatory affairs. Rome's strength lies in its clinical emphasis and integration with medical faculties, making it attractive for inbound students focused on advanced pharmacotherapy, hospital pharmacy, and pharmacogenomics. Challenges include the need to streamline elective clustering to avoid overlap with compulsory modules.

Table C-10. Key indicators – University of Rome

Indicator	Value
Total ECTS (listed)	312.0
Total Courses (n)	140
Electives (n)	18
Electives ECTS	44.0
Electives share (%)	14.1%
Basic Sciences	92.0
Pharmaceutical Sciences	94.0
Biomedical/Clinical Sciences	92.0
Professional/Regulatory Sciences	34.0

5.11 University of Padua

Padua offers a comprehensive and balanced curriculum (≈306 ECTS) with a strong Basic (94.0) and Pharmaceutical (92.0) base, reinforced by Biomedical/Clinical (88.0) and Professional/Regulatory (32.0). Elective share (13.7%) is sufficient to support mobility, especially in drug delivery, regulatory science, and clinical PK. Strengths: well-balanced subject allocation, robust elective catalogue. Weakness: electives moderately dispersed across semesters, which may complicate short-term inbound mobility. Strategic recommendation: consolidate electives into semester clusters to enhance accessibility for exchange students.

Table C-11. Key indicators – University of Padua

Indicator	Value
Total ECTS (listed)	306.0
Total Courses (n)	144
Electives (n)	19
Electives ECTS	42.0
Electives share (%)	13.7%
Basic Sciences	94.0

Pharmaceutical Sciences	92.0
Biomedical/Clinical Sciences	88.0
Professional/Regulatory Sciences	32.0

5.12 University of Naples

Naples positions itself with a technology-oriented profile: Pharmaceutical Sciences (98.0) are among the highest, complemented by strong Basic (96.0) and Biomedical/Clinical (90.0). Professional/Regulatory (34.0) aligns with Italian standards. Electives (15.7%) are plentiful, supporting late-stage mobility, particularly in pharmaceutics, regulatory sciences, and industrial pharmacy. Strengths: extensive elective offer, strong industrial alignment, balanced biomedical training. Challenges: ensuring that elective timetables are published in advance to optimise inbound student choices. Naples is ideal for mobility in industrial pharmacy, advanced drug delivery, and regulatory CMC.

Table C-12. Key indicators – University of Naples

Indicator	Value
Total ECTS (listed)	318.0
Total Courses (n)	150
Electives (n)	23
Electives ECTS	50.0
Electives share (%)	15.7%
Basic Sciences	96.0
Pharmaceutical Sciences	98.0
Biomedical/Clinical Sciences	90.0
Professional/Regulatory Sciences	34.0

Executive Summary

The SYMBIOEDU comparative analysis consolidates data from twelve European universities of pharmacy: Valencia, Coimbra, Bratislava, Sofia, Pisa, Bologna, Ferrara, Perugia, Milan, Rome, Padua, and Naples. Together, these institutions represent diverse national traditions yet converge on the shared goal of harmonising pharmacy curricula within the framework of the EU Directive 2005/36/EC.

The study reveals four main findings:

1. **Structural Convergence.**
   All partners implement a five-year integrated programme (≈300 ECTS), with comparable

sequencing of Basic, Pharmaceutical, Biomedical/Clinical, and Professional/Regulatory sciences.

2. **Balanced ECTS Distribution.**
   Basic Sciences account for ≈30–33% of curricula, Pharmaceutical Sciences for ≈28–31%, Biomedical/Clinical Sciences for ≈28–30%, and Professional/Regulatory Sciences for ≈10–11%. This distribution demonstrates broad alignment with professional requirements.
3. **Elective Offer and Mobility Potential.**
   Electives vary widely: from <10% of curricula in Coimbra, Sofia, Perugia, to ≥15–20% in Bologna, Valencia, Naples. Universities with greater elective density offer stronger opportunities for inbound and outbound mobility.
4. **Mobility Windows.**
   Semesters 7–10 emerge as optimal windows for Erasmus exchanges, particularly in institutions with elective clusters. Institutions with compulsory modules across all semesters (e.g., Sofia, Perugia) face greater challenges, but can develop micro-windows anchored in professional rotations.

Overall, the analysis confirms that the consortium is well-positioned to deliver a harmonised curriculum while leveraging elective diversity to strengthen internationalisation and student mobility.

Executive Summary- Key Strategic Messages

- Convergence exists: All programmes share a strong scientific core and comparable professional outcomes.
- Electives drive differentiation: Their density and timing are the main determinants of mobility potential.
- Mobility tracks can be formalised: Clinical & Therapeutics, Pharmaceutics & Industrial, Regulatory & Quality clusters can anchor exchanges.
- Recognition requires transparency: Shared outcomes grids, harmonised calendars, and published elective catalogues are essential.
- Strategic opportunity: The consortium can position itself as a model of curricular harmonisation in European pharmacy education, combining comparability with institutional diversity.

Conclusions and Recommendations

The comparative analysis yields several conclusions:

1. Strong scientific foundations underpin all programmes, guaranteeing graduate readiness for professional and academic careers.
2. Curricular variations lie mainly in sequencing and elective density, not in overall content. These variations create opportunities for mobility if managed strategically.
3. Mobility windows in Semesters 7–10 offer the greatest potential, provided elective clusters are coordinated and timetables harmonised.

4. Professional/Regulatory content is uneven across partners; harmonisation should aim at a minimum baseline (≈30 ECTS).
5. Industrial and clinical strengths of specific universities can be leveraged for specialised mobility tracks (e.g., pharmaceutics in Pisa/Naples; clinical pharmacotherapy in Rome/Milan).

Recommendations:

- Adopt a shared reference grid for compulsory subjects and ECTS bands, ensuring transparency in recognition.
- Publish a consortium elective catalogue with semester tags, outcomes, and prerequisites, updated annually.
- Formalise mobility tracks around complementary strengths (Industrial/Pharmaceutics, Clinical/Pharmacotherapy, Regulatory/Professional).
- Synchronise academic calendars (±2 weeks) to minimise timetable conflicts.
- Define common standards for professional practice (minimum ECTS in community/hospital rotations, ethics, and law).
- **Expand digital and inter-professional modules** (data analytics, communication, public health) as transversal electives.

In conclusion, the consortium has achieved a high degree of structural convergence while retaining diversity in elective provision. By aligning elective design, publishing transparent catalogues, and formalising mobility tracks, the SYMBIOEDU partnership can both **strengthen harmonisation** and **enhance its international profile** as a reference for European pharmacy education.

Annexes

Annex I – University of Valencia

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
GENERAL CHEMISTRY	I	6	Compulsory	
PHYSICS	I	6	Compulsory	
STATISTICS	I	6	Compulsory	
DOCUMENTATION AND SCIENTIFICS METHODOLOGY	I	4.5	Compulsory	
GENERAL BIOLOGY	I	6	Compulsory	

INORGANIC CHEMISTRY	II	4.5	Compulsory
INSTRUMENTAL TECHNIQUES	II	6	Compulsory
PHYSICAL CHEMISTRY	II	6	Compulsory
PLANT PHYSIOLOGY	II	4.5	Compulsory
BOTANY	II	4.5	Compulsory
HUMAN ANATOMY	II	6	Compulsory
BIOCHEMISTRY I	III	6	Compulsory
PHYSIOLOGY I	III	6	Compulsory
ORGANIC CHEMISTRY	III & IV	12	Compulsory
CHEMICAL ANALYSIS	III & IV	9	Compulsory
MICROBIOLOGY	III & IV	10.5	Compulsory
BIOCHEMISTRY II	IV	6	Compulsory
PHYSIOLOGY II	IV	6	Compulsory
IMMUNOLOGY	IV	4.5	Compulsory
NUTRITION AND FOOD SCIENCES	V	6	Compulsory
PHYSIOPATHOLOGY	V	6	Compulsory
PHARMACEUTICAL CHEMISTRY	V & VI	12	Compulsory
PHARMACOGNOSY	V & VI	9	Compulsory
BIOPHARMACY AND PHARMACOKINETICS	V & VI	10.5	Compulsory
CLINICAL NUTRITION	VI	4.5	Compulsory
PHARMACOLOGY I	VI	6	Compulsory
PARASITOLOGY	VI	6	Compulsory

MICROBIOLOGICAL AND PARASITOLOGICAL ANALYSES	VII	6	Compulsory
PHARMACEUTICAL MANAGEMENT AND PLANNING	VII	4.5	Compulsory
PHARMACEUTICAL TECHNOLOGY I	VII & VIII	12	Compulsory
PHARMACOLOGY II (*)	VII & VIII	9	Compulsory
TOXICOLOGY (**)	VII & VIII	9	Compulsory
PUBLIC HEALTH	VII & VIII	9	Compulsory
LEGISLATION AND PHARMACEUTICAL DEONTOLOGY	VIII	4.5	Compulsory
CLINICAL BIOCHEMISTRY AND HEMATOLOGY(***)	VIII	6	Compulsory
PHARMACEUTICAL TECHNOLOGY II	IX	6	Compulsory
CLINICAL PHARMACY AND PHARMACEUTICAL CARE	IX	6	Compulsory
TUTORED INTERNSHIPS	IX & X	24	Compulsory
DEGREE FINAL PROJECT IN PHARMACY	IX & X	6	Compulsory
Elective course 1, 2, 3, 4	IX & X	18	Elective
Elective Courses	Semester	ECTS	Elective
ORTHOPAEDICS	IX	4.5	Elective
NUTRITIONAL PHARMACEUTICS	IX	4.5	Elective
PHYTOTHERAPY	IX	4.5	Elective
PHARMACOTHERAPY	IX	4.5	Elective

DERMOPHARMACY	IX	4.5	Elective
ANALYSIS AND CONTROL PHARMACEUTICALS AND COSMETICS PRODUCTS	IX	4.5	Elective
NEW PERSPECTIVES AND PHARMACEUTICAL DESIGN AND SYNTHESIS	IX	4.5	Elective
RADIOPHARMACY	IX	4.5	Elective
PHARMACOEPIDEMIOLOGY	IX	4.5	Elective
CLINICAL MICROBIOLOGY	IX	4.5	Elective
CLINICAL PARASITOLOGY	IX	4.5	Elective
CLINICAL BIOCHEMISTRY AND MOLECULAR PATHOLOGY	IX	4.5	Elective
FOOD AND CULTURE	X	4.5	Elective
ECONOMICS AND BUSINESS	X	4.5	Elective
MOLECULAR PATHOLOGY	X	4.5	Elective
NUTRITIONAL PATHOLOGY	X	4.5	Elective

Table A1. Course list – University of Valencia

Annex II – University of Coimbra

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Applied Physics	I	5.5	Compulsory	Pharmaceutical Physics
Cell Biology	I	6	Compulsory	Latin medical terminology
General and Inorganic Chemistry	I	5	Compulsory	Microbiology

History of Pharmacy and Pharmaceutical Activity	I	3	Compulsory	General Biology
Human Histology and Embryology	I	5	Compulsory	General and Inorganic Chemistry
Mathematics	I	5.5	Compulsory	Matematics for Pharmacists
Analytical Chemistry	II	6	Compulsory	Analytical Chemistry (1)
Molecular Biology	II	4.5	Compulsory	Anatomy and Physiology
Organic Chemistry I	II	5.5	Compulsory	Physical chemistry
Pharmaceutical Botany	II	4.5	Compulsory	
Physical Chemistry	II	4	Compulsory	
Statistics	II	5.5	Compulsory	
Biochemistry I	III	5	Compulsory	Analytical Chemistry (2)
Galenical Pharmacy	III	4.5	Compulsory	Immunology
General Microbiology	III	5	Compulsory	Organic Chemistry (2)
Human Anatomy and Physiology I	III	5	Compulsory	Pathology
Instrumental Methods of Analysis I	III	5	Compulsory	Biochemistry
Organic Chemistry II	III	5.5	Compulsory	Pharmaceutical Botany
Biochemistry II	IV	5.5	Compulsory	Pharmacology (1)G
General Pharmacology	IV	5	Compulsory	Social Pharmacy and Pharmacoeconomics
Heamatology and Imunology	IV	5	Compulsory	

Human Anatomophysiology II	IV	5.5	Compulsory	
Human Physiopathology	IV	3.5	Compulsory	
Instrumental Methods of Analysis II	IV	5.5	Compulsory	
Biopharmacy and Pharmacokinetics	V	4	Compulsory	Applied Biochemistry
Human Nutrition	V	4.5	Compulsory	Pharmaceutical Chemistry (1)
Pharmaceutical Chemistry I	V	5.5	Compulsory	Pharmacognosy (1)
Pharmacognosy	V	5	Compulsory	Analytical monitoring of drug levels in practice
Pharmacology I	V	5.5	Compulsory	Pharmacology (2)H
Hydrology and Hydrological Analysis	VI	4.5	Compulsory	Pharmaceutical Chemistry (2)
Medical Herbs	VI	4.5	Compulsory	Pharmacognosy (2)
Parasitology and Parasitological Analyses	VI	5	Compulsory	Pharmaceutical Technology (1)
Pharmaceutical Chemistry II	VI	5	Compulsory	
Pharmaceutical Technology I	VI	5.5	Compulsory	
Pharmacology II	VI	5.5	Compulsory	
Bromatology and Bromatological Analysis	VII	5	Compulsory	Drug Analysis
Clinical Biochemistry	VII	4	Compulsory	Pharmaceutical Technology (2)

Dermopharmacy and Cosmetics	VII	4	Compulsory	Clinical Pharmacology and Pharmacotherapy
Phamaceutical Deontology and Law	VII	4	Compulsory	Diploma Thesis Preparation (1)
Pharmaceutical Technology II	VII	5	Compulsory	Toxicology I
Pharmacotherapy	VII	4	Compulsory	Public Health and Pharmaceutical Care
Virology	VII	4	Compulsory	Clinical Pharmacy and Pharmacotherapy
Clinical Pharmacy	VIII	4	Compulsory	Retail Pharmacy, Legislation and Ethics
Management and Quality Assurance	VIII	4	Compulsory	Diploma Thesis Preparation (2)
Pharmaceutical Administration and Organization	VIII	4	Compulsory	Technology of Biological Drugs
Pharmaceutical Technology III	VIII	5	Compulsory	
Regulatory Issues of Medicinal Products	VIII	5	Compulsory	
Toxicology and Toxicological Analysis	VIII	5	Compulsory	
Curricular Internship	IX	36	Compulsory	Practice in Community Pharmacy (1)
Hospital Pharmacy	IX	3	Compulsory	Practice in Community Pharmacy (2)

Pharmaceitical Biotechnology	IX	3	Compulsory	Diploma Thesis Preparation (3)
Pharmaceutical Indication	IX	3	Compulsory	
Pharmaceutical Marketing and Communication	IX	3	Compulsory	
Pharmacovigilance and Pharmacoepidemiology	IX	3	Compulsory	
Phytotherapy	IX	3	Compulsory	
Preparation for Veterinary Use	IX	3	Compulsory	
Elective course 1, 2, 3, 4	VIII & IX	12	Elective	
Course title	Semester	ECTS	Elective	Course title
Drug Monitoring in Personalized Pharmacotherapy	VIII	3.0	Elective	COMPULSORY ELECTIVE
Intellectual Property, Innovation and Entrepreneurship	VIII	3.0	Elective	Computer Data Processing
Neurobiology and Disease	VIII	3.0	Elective	History of Pharmacy
Production Technology for Vaccines and Adjuvants	VIII	3.0	Elective	Pharmaceutical Propedeutics
Public Health and Epidemiology	VIII	3.0	Elective	Physical Education and Sports (1)
Scientific Research and Science Communication	VIII	3.0	Elective	Selected Chapters in Inorganic Chemistry

Sociology of Health	VIII	3.0	Elective	Slovak Language for International Students (1)
Biochemistry Pharmacotoxicology	IX	3.0	Elective	Academic English Language Preparation (1)
Clinical Pharmaceutical Services	IX	3.0	Elective	First Aid
Health Information Management	IX	3.0	Elective	Latin Pharmaceutical Terminology
Medical Devices	IX	3.0	Elective	Physical Education and Sports (2)
Pharmaceutical Nanotechnology	IX	3.0	Elective	Selected Topics in Organic Chemistry
Pharmacotherapeutic Evaluation in Primary Health Care	IX	3.0	Elective	Slovak Language for International Students (2)
Regulatory Process Management	IX	3.0	Elective	Bioorganic Chemistry

Table A2. Course list – University of Coimbra

Annex III – Comenius University Bratislava

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Pharmaceutical Physics	I	5	Compulsory	
Latin medical terminology	I	2	Compulsory	
Microbiology	I	5	Compulsory	
General Biology	I	6	Compulsory	

General and Inorganic Chemistry	I	9	Compulsory
Matematics for Pharmacists	I	3	Compulsory
Analytical Chemistry (1)	II	9	Compulsory
Anatomy and Physiology	II	7	Compulsory
Physical chemistry	II	1	Compulsory
Analytical Chemistry (2)	III	8	Compulsory
Immunology	III	5	Compulsory
Organic Chemistry (2)	III	6	Compulsory
Pathology	III	6	Compulsory
Biochemistry	IV	8	Compulsory
Pharmaceutical Botany	IV	6	Compulsory
Pharmacology (1)G	IV	6	Compulsory
Social Pharmacy and Pharmacoeconomics	IV	5	Compulsory
Applied Biochemistry	V	4	Compulsory
Pharmaceutical Chemistry (1)	V	5	Compulsory
Pharmacognosy (1)	V	7	Compulsory
Analytical monitoring of drug levels in practice	V	7	Compulsory
Pharmacology (2)H	V	7	Compulsory
Pharmaceutical Chemistry (2)	VI	8	Compulsory

Pharmacognosy (2)	VI	8	Compulsory
Pharmaceutical Technology (1)	VI	9	Compulsory
Drug Analysis	VII	8	Compulsory
Pharmaceutical Technology (2)	VII	9	Compulsory
Clinical Pharmacology and Pharmacotherapy	VII	4	Compulsory
Diploma Thesis Preparation (1)	VII	3	Compulsory
Toxicology I	VII	3	Compulsory
Public Health and Pharmaceutical Care	VII	5	Compulsory
Clinical Pharmacy and Pharmacotherapy	VIII	6	Compulsory
Retail Pharmacy, Legislation and Ethics	VIII	4	Compulsory
Diploma Thesis Preparation (2)	VIII	4	Compulsory
Technology of Biological Drugs	VIII	4	Compulsory
Practice in Community Pharmacy (1)	IX	20	Compulsory
Practice in Community Pharmacy (2)	X	6	Compulsory
Diploma Thesis Preparation (3)	X	10	Compulsory
Course title	Semester	ECTS	Elective

COMPULSORY ELECTIVE			Elective	Year
Computer Data Processing	WS	2	Compulsory	
History of Pharmacy	WS	2	Compulsory	1st-5th
Pharmaceutical Propedeutics	WS	2	Compulsory	1st-5th
Physical Education and Sports (1)	WS	1	Compulsory	1
Selected Chapters in Inorganic Chemistry	WS	2	Compulsory	1st-4th
Slovak Language for International Students (1)	WS	2	Compulsory	1
Academic English Language Preparation (1)	SS	2	Compulsory	1st-5th
First Aid	SS	2	Compulsory	1st-5th
Latin Pharmaceutical Terminology	SS	2	Compulsory	1st-4th
Physical Education and Sports (2)	SS	1	Compulsory	1
Selected Topics in Organic Chemistry	SS	2	Compulsory	1st-5th
Slovak Language for International Students (2)	SS	2	Compulsory	1
Bioorganic Chemistry	WS	2	Compulsory	1st-5th
Biophysics	WS	3	Compulsory	2nd-3rd
Hygiene of Pharmaceutical Facilities	WS	3	Compulsory	2nd-3rd

Academic English Language Preparation (2)	WS	2	Compulsory	2nd-3rd
Pathology of Rare Diseases	WS	2	Compulsory	1,2-5th
Physical Education and Sports (3)	WS	1	Compulsory	2nd-3rd
Validation in Analytical and Pharmaceutical Practice	WS	2	Compulsory	1,2-5th
Biostatistics for Pharmacists	SS	3	Compulsory	2nd-5th
Pharmaceutical Informatics	SS	3	Compulsory	2
Medical Propedeutics	SS	2	Compulsory	1,2-5th
New Trends in Analytical Chemistry	SS	3	Compulsory	2nd-3rd
Research Project and Presentation	SS	2	Compulsory	2nd-4th
Physical Education and Sports (4)	SS	1	Compulsory	1,2-5th
Management Basics in Pharmacy	SS	3	Compulsory	1,2-5th
Principles of Molecular Modelling	SS	2	Compulsory	1,2-5th
Analysis of Substances in Biological System	WS	3	Compulsory	2
Immunodiagnostics	WS	2	Compulsory	3rd-4th
Medicinal Plants	WS	2	Compulsory	3rd-4th

Molecular Biology of Drugs	WS	3	Compulsory	3
Radiopharmaceuticals	WS	4	Compulsory	3rd-4th
Medical Devices	WS	2	Compulsory	3
Pharmacology of Orphan Drugs	SS	2	Compulsory	3
Metallodrugs and Nanoparticles as Modern Pharmaceuticals	SS	2	Compulsory	3rd-4th
Molecular Basis of Drug Development	SS	3	Compulsory	3rd-4th
Current Trends in Preparations of Natural Origin	SS	2	Compulsory	3rd-4th
Physical Activities and Health	SS	2	Compulsory	3
Veterinary Pharmacology	SS	3	Compulsory	3rd-4th
Xenobiochemistry	SS	3	Compulsory	3rd-4th
Safety of Herbal Medicines and Food Supplements	WS	3	Compulsory	3rd-4th
Medical writing	WS	2	Compulsory	4
Advanced Cell-Biology Methods	WS	3	Compulsory	4
Good Manufacturing Drugs Practice	WS	3	Compulsory	4
Technology of Natural Drugs	WS	3	Compulsory	4
Diet and Nutrition Basics	WS	3	Compulsory	

Health Psychology	WS	2	Compulsory	4
Pharmacokinetic Modelling and Drug Development	SS	3	Compulsory	4
Health Technology Assessment	SS	2	Compulsory	4
Inovative Dosage Form and Biological Medicines	SS	3	Compulsory	2nd-4th
Inovative Medicines in Pharmacotherapy	SS	2	Compulsory	4
Cosmetics in Pharmacy	SS	3	Compulsory	4
Hospital Pharmacy	SS	2	Compulsory	4
Advanced Pharmaceutical Compounding	SS	2	Compulsory	4
Legal Rudiments for Pharmacists	SS	3	Compulsory	4
Basics of Regulatory Pharmacy	SS	2	Compulsory	3rd-4th
Trends in European Pharmaceutical Education	WS/SS	2	Compulsory	4
ELECTIVE			Elective	2nd-4th
Problem Solving in Pharmaceutical Physics	1	WS	Elective	
Academic German Language Preparation (1)	1	SS	Elective	1st-5th
Problem Solving in Physical Chemistry	1	SS	Elective	1st-5th

Calculations in Chemical Analysis	1	SS	Elective	1st-5th
Academic German Language Preparation (2)	1	WS	Elective	1st-5th
Academic English Language Preparation (3)	1	SS	Elective	1st, 2nd-5th
Academic German Language Preparation (3)	1	SS	Elective	1st, 2nd-5th
Academic English Language Preparation (4)	1	WS	Elective	1st, 2nd-5th
Academic German Language Preparation (4)	1	WS	Elective	1st-3rd
Physical Education and Sports (5)	1	WS	Elective	1st-3rd
Academic English Language Preparation (5)	1	SS	Elective	1st-3rd
Academic German Language Preparation (5)	1	SS	Elective	1st-3rd
Pharmaceutical Intership	2	as planned	Elective	1st-4th
Non-faculty Study Activities	1	as planned	Elective	1st-5th
Student Scientifics Activity	1	as planned	Elective	1st-5th

Table A3. Course list – Comenius University Bratislava

Annex IV – Medical University Sofia

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Year	Analytical Toxicology	7-9	Elective	4
1st-5th	Bioinorganic chemistry	7-9	Compulsory	4
1st-5th	Bioorganic Chemistry	7-9	Compulsory	4
1	Biophysical Chemistry	7-9	Compulsory	4
1st-4th	Bromatology	7-9	Compulsory	4
1	Cosmetic materials and care	7-9	Compulsory	4
1st-5th	Coordination Compounds in Medicine	7-9	Compulsory	4
1st-5th	Molecular Modelling of Pharmacophores	7-9	Compulsory	4
1st-4th	Nanotechnologies in Pharmacy	7-9	Compulsory	4
1	Chemistry of Natural Products	7-9	Compulsory	4
1st-5th	QSAR and Drug Design	7-9	Compulsory	4
1	Optional Courses	Semester	Compulsory	ECTS
1st-5th	Introduction to University Chemistry	0	Compulsory	1

2nd-3rd	Basic Mathematics	0	Compulsory	1
2nd-3rd	Fundamentals of Pharmaceutics	0	Compulsory	2.3
2nd-3rd	Optical and Electron Microscopy	0	Compulsory	3-9
1,2-5th			Compulsory	
2nd-3rd			Compulsory	
2nd-5th			Compulsory	
2			Compulsory	
2nd-4th			Compulsory	
3rd-4th			Compulsory	
3			Compulsory	
4			Compulsory	
1st-5th			Compulsory	
1st, 2nd-5th			Compulsory	
1st-3rd			Compulsory	
1st-4th			Compulsory	

Table A4. Course list – Medical University Sofia

Annex V – University of Pisa

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Animal and Plant Biology	1st	I	Compulsory	9
Human Anatomy		I	Compulsory	6

General and Inorganic Chemistry		I	Compulsory	10
General Physics and Elements of Mathematics		I	Compulsory	6
Hygiene		II	Compulsory	6
Microbiology		II	Compulsory	6
Computer Science and Medical Statistics		II	Compulsory	6
Scientific English		II	Compulsory	5
Analytical Chemistry	2nd	I	Compulsory	6
General and Clinical Pathology		I	Compulsory	6
Human Physiology		I	Compulsory	9
Organic Chemistry		II	Compulsory	12
Pharmacognosy and Pharmaceutical Botany		II	Compulsory	9
Qualitative Analysis of Medicines I		II	Compulsory	6
Quantitative Analysis of Medicines		II	Compulsory	6
Nutrition Science		II	Compulsory	6
Food Chemistry and Dietary Supplements	3rd	I	Compulsory	6
General and Molecular Biochemistry		I	Compulsory	12
General Pharmacology		I	Compulsory	12
Pharmaceutical Chemistry and Toxicology II		II	Compulsory	9

Pharmaceutical Chemistry I		II	Compulsory	9
Pharmaceutical Legislation and Pharmacoeconomics		II	Compulsory	12
Applied Medical Biochemistry	4th	I	Compulsory	9
Drug Analysis II		I	Compulsory	12
Molecular Basis of Biotechnological Drug Activity		I	Compulsory	6
Pharmaceutical Technology and Galenic Preparations Lab		II	Compulsory	12
Pharmacology and Pharmacotherapy II		II	Compulsory	12
Pharmacovigilance and Pharmacoepidemiology		II	Compulsory	6
Internship (Part 1)		II	Compulsory	9
Advanced Pharmaceutical Technology and Medical Devices	5th	I	Compulsory	6
Internship (Part 2)		I	Compulsory	21
Final Dissertation		II	Compulsory	15
Toxicology		II	Compulsory	6
Elective Courses (select 12 ECTS from a list of 24 options)		II	Elective	12
Focused Lab Training		II	Elective	6
Metagenomics		II	Elective	6

Molecular Genetics and Molecular Medicine in the AI-era	II	Elective	6
The Law and Ethics of AI-driven Biomedical Innovation	II	Elective	6
Territorial Clinical Pharmacy	II	Elective	3
Management of minor pathologies by the pharmacist	II	Elective	3
Evidence-based medicine and communication on drugs and vaccines	II	Elective	3
Elements of Internal Medicine	II	Elective	3
Veterinary drug	II	Elective	3
Professional and managerial aspects of the pharmacist's activity	II	Elective	3
Biopharmaceutical	II	Elective	3
Pharmacist preparer and personalized therapy	II	Elective	3
Cosmetics	II	Elective	3
Biological evaluation of the activity of therapeutic and diagnostic products	II	Elective	3
Molecular basis of innovative gene and cell therapies	II	Elective	3

Applied Pharmacology	II	Elective	3
Advanced Synthetic Methods in Medicinal Chemistry	II	Elective	3
Laboratory chemical techniques for the identification of new bioactive molecules	II	Elective	3
Computational methods in medicinal chemistry	II	Elective	3
Management of medicinal plants in pharmacies	II	Elective	3
Botanicals: from Ethnobotany to the modern health product	II	Elective	3
Chemistry and health properties of nutraceuticals	II	Elective	3
Nutraceuticals and applications in the prevention of pathological states	II	Elective	3
The Pharmacy System	II	Elective	3
Management and taxation tools in Pharmacy	II	Elective	3
Pharmacy Ethics and Marketing	II	Elective	3
The new pharmacy of Services	II	Elective	3

Table A5. Course list – University of Pisa

Annex VI – University of Bologna

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Course	Year	Semester	Compulsory	ECTS
Plant Biology and Pharmaceutical Botany	1st	I	Compulsory	9
Human Anatomy		I	Compulsory	8
Animal Biology		I	Compulsory	3
Elements of Mathematics		II	Compulsory	6
Physics		II	Compulsory	6
Scientific English		II	Compulsory	3
Analytical Chemistry	2nd	I	Compulsory	6
Organic Chemistry		I	Compulsory	9
Medical Microbiology and Vaccines		I	Compulsory	9
Drug and Health Product Analysis I		II	Compulsory	8
General, Molecular and Metabolic Biochemistry		II	Compulsory	8
Food Chemistry and Nutraceuticals		II	Compulsory	6
Human Physiology		II	Compulsory	9
Drug and Health Product Analysis II	3rd	I	Compulsory	8
Applied Medical Biochemistry		I	Compulsory	6

Pharmaceutical and Toxicological Chemistry I		I	Compulsory	9
General and Clinical Pathology		II	Compulsory	10
Pharmaceutical Technology		II	Compulsory	6
General Pharmacology and Pharmacotherapy I		II	Compulsory	9
Professional Activities (choose one, 9 ECTS)		II	Compulsory	9
Phytopharmaceuticals: From Nature to Drug (C.I.)		II	Compulsory	9
Nutrition and Food Supplementation		II	Compulsory	9
Nutrition Biochemistry		II	Compulsory	6
Food Chemistry		II	Compulsory	3
Pharmaceutical and Toxicological Chemistry II	4th	I	Compulsory	9
Pharmacology and Pharmacotherapy II		I	Compulsory	10
Pharmaceutical Law, Ethics, and Pharmacy Management		I	Compulsory	6
Pharmacovigilance and Pharmacoepidemiology		II	Compulsory	6
Pharmaceutical Technology and Galenic Preparations Lab		II	Compulsory	8
Toxicology		II	Compulsory	9

Dermocosmetics (C.I.)		II	Compulsory	9
Biological Drugs and Rare Diseases (C.I.)		II	Compulsory	9
Internship (900 hours)	5th	I	Compulsory	30
Final Dissertation		II	Compulsory	3
Elective courses		II	Elective	
ACQUISITION OF MANAGEMENT AND INTERPERSONAL SKILLS			Elective	4
CELLULAR AND MOLECULAR PHARMACOLOGY			Elective	4
PHYSIOLOGY OF SENESCENCE AND LONGEVITY			Elective	4
AGING AND NEURODEGENERATIVE DISEASES			Elective	9
LIGHT IN PHARMACIES			Elective	4
COGNITIVE NEUROPHYSIOLOGY			Elective	4
NOTIONS OF FIRST AID			Elective	4

Table A6. Course list – University of Bologna

Annex VII – University of Ferrara

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
General and Inorganic Chemistry	I	12	Compulsory	

Mathematics and Physics	I	8	Compulsory
Biology (Animal and Plant)	I	6	Compulsory
Human Anatomy	II	6	Compulsory
Computer Science	II	3	Compulsory
Analytical Chemistry	II	6	Compulsory
2nd			Compulsory
Biochemistry	I	10	Compulsory
Organic Chemistry	I	10	Compulsory
General Microbiology	I	6	Compulsory
Pharmaceutical Analysis of Drugs I	II	10	Compulsory
Applied Biochemistry	II	10	Compulsory
Pharmaceutical Botany	II	8	Compulsory
Pharmacognosy	II	8	Compulsory
Hygiene	II	6	Compulsory
3rd			Compulsory
Pharmaceutical Analysis of Drugs II	I	10	Compulsory
Pharmaceutical and Toxicological Chemistry I	I	8	Compulsory

Pharmaceutical Technology, Socioeconomics, and Regulations I	I	10	Compulsory
Pharmaceutical Analysis of Drugs III	II	10	Compulsory
Pathology	II	6	Compulsory
Physiology	II	8	Compulsory
4th			Compulsory
Pharmaceutical and Toxicological Chemistry II	I	8	Compulsory
Pharmacology and Pharmacotherapy	I	10	Compulsory
Food Chemistry	I	6	Compulsory
Food and Nutrition Science	II	8	Compulsory
Pharmaceutical and Toxicological Chemistry III	II	6	Compulsory
Pharmaceutical Technology, Socioeconomics, and Regulations II	II	10	Compulsory
Chemistry of Make-up Products	II	8	Compulsory
Toxicology	II	8	Compulsory
5th			Compulsory
English Language	I	4	Compulsory

Elective Courses (Suggested)	I	12	Elective
Professional Practice (Internship)	II	30	Compulsory
Final Dissertation	II	15	Compulsory
Elective Courses	Semester	ECTS	Elective
Analytical Methodologies for the Characterization of Foods and Nutraceuticals	II	6	Elective
History of Pharmacy and Medicines	II	6	Elective
Algae, Lichens, and Medicinal Mushrooms for Health Products	II	6	Elective
New Pharmaceutical Technologies and Their Impact on Production and Innovation	II	6	Elective
Quality Assurance: Principles and Applications in the Pharmaceutical Field	II	6	Elective
Green Chemistry in	II	6	Elective

Biotechnological Productions			
Biotechnological Drugs	II	6	Elective
Chemistry of Functional Foods	II	6	Elective
Economic Botany and Functional Products	II	6	Elective
Applied Biocatalysis for Drugs and Health Products	II	6	Elective
Economics and Management of Healthcare Companies	II	6	Elective
Business Plan	II	6	Elective
Basic Biochemistry of Cancer	II	6	Elective
Drug Engineering and Repositioning Approaches	II	6	Elective
Omics and Molecular Diagnostics	II	6	Elective
Tissue Bioengineering and Health Products	II	6	Elective
Medical Statistics	II	6	Elective

Table A7. Course list – University of Ferrara

Annex VIII – University of Perugia

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Animal and Plant Biology	I	11	Compulsory	
Medical Statistics, Computer Science, and Mathematics	I	9	Compulsory	
General and Inorganic Chemistry	I	10	Compulsory	
Human Anatomy	II	8	Compulsory	
Physics	II	6	Compulsory	
English Language B2	Annual	6	Compulsory	
2nd			Compulsory	
Organic Chemistry	I	12	Compulsory	
Microbiology and Hygiene	I	12	Compulsory	
Analytical Chemistry	I	6	Compulsory	
Physiology	II	10	Compulsory	
Elements of Botany and Pharmacognosy	II	8	Compulsory	
General and Molecular Biochemistry	II	12	Compulsory	
3rd			Compulsory	
Food and Diet Products	I	6	Compulsory	

General and Clinical Pathology	I	8	Compulsory
Medicinal Chemistry I	I	11	Compulsory
Food Science	II	6	Compulsory
Medical Biochemistry	II	6	Compulsory
Pharmacology and Pharmacotherapy I	II	12	Compulsory
Drug Analysis I	Annual	10	Compulsory
4th			Compulsory
Dietetics for Endocrine and Metabolic Disorders	I	4	Compulsory
Bioinorganic Chemistry and Materials	I	4	Compulsory
Cellular and Medical Biochemistry	II	4	Compulsory
Complementary and Alternative Medicine	II	4	Compulsory
Cosmetic Products	II	4	Compulsory
Drug Analysis II	II	12	Compulsory
5th			Compulsory
Elective Courses	I	12	Elective
Professional Practice (Internship)	II	30	Compulsory
Final Dissertation	II	15	Compulsory
Elective Courses	Semester	ECTS	Elective

Advanced Pharmaceutical Analysis	II	6	Elective
Nutraceuticals and Functional Foods	II	6	Elective
Cosmetic Science and Technology	II	6	Elective
Pharmacoeconomics and Health Technology Assessment	II	6	Elective
Clinical Pharmacy and Patient Care	II	6	Elective
Herbal Medicines and Phytotherapy	II	6	Elective
Regulatory Affairs and Pharmaceutical Legislation	II	6	Elective
Biotechnological Drugs and Personalized Medicine	II	6	Elective
Environmental Impact of Pharmaceuticals	II	6	Elective
Advanced Topics in Pharmacology	II	6	Elective

Table A8. Course list – University of Perugia

Annex IX – University of Milan

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations

Semester	ECTS	Compulsory	Compulsory
I	12	Compulsory	Pharmaceutical Biology
I	8	Compulsory	Human Anatomy
I	6	Compulsory	Mathematics with Elements of Computer Science
II	6	Compulsory	General and Inorganic Chemistry
II	3	Compulsory	Physics with Elements of Statistics
II	6	Compulsory	Pharmaceutical Botany
I	10	Compulsory	2nd
I	10	Compulsory	Organic Chemistry
I	6	Compulsory	Human Physiology
II	10	Compulsory	Analytical Chemistry and Complements of General Chemistry with Elements of Nuclear Medicine
II	10	Compulsory	Elective Course (Student's Choice)
II	8	Compulsory	Drug Analysis with Laboratory
II	8	Compulsory	Microbiology
II	6	Compulsory	Hygiene and Health Management
I	10	Compulsory	CHEMISTRY OF FOOD AND DIET PRODUCTS WITH NUTRACEUTICAL ELEMENTS
I	8	Compulsory	General pathology and laboratory diagnostics

I	10	Compulsory	GENERAL BIOCHEMISTRY
II	10	Compulsory	Elective course
II	6	Compulsory	ANALYSIS OF MEDICINAL PRODUCTS I WITH LABORATORY
II	8	Compulsory	PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY I
I	8	Compulsory	GENERAL PHARMACOLOGY AND PHARMACOTHERAPY I
I	10	Compulsory	Pharmaceutical technology and drug regulation conventional pharmaceutical forms - Galenic preparation laboratory
I	6	Compulsory	PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY II
II	8	Compulsory	ANALYSIS OF MEDICINAL PRODUCTS II WITH LABORATORY
II	6	Compulsory	PHARMACOLOGY AND PHARMACOTHERAPY II
II	10	Compulsory	Practical apprenticeship A
II	8	Compulsory	5th
II	8	Compulsory	PHARMACOGNOSY AND PHYTOTHERAPY
I	4	Compulsory	Pharmaceutics law and ethics Innovative dosage forms and health products Pharmacy management

I	12	Elective	FINAL EXAM
II	30	Compulsory	Practical apprenticeship
II	15	Compulsory	
Semester	ECTS	Elective	COMPLEMENTS OF PHARMACEUTICAL AND TOXICOLOGY CHEMISTRY
I	9	Elective	FOOD SCIENCE
I	8	Elective	APPLIED BIOCHEMISTRY
I	8	Elective	FARMACOEPIDEMIOLOGIA E FARMACOECONOMIA

Table A9. Course list – University of Milan

Annex X – University of Rome

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Pharmaceutical Biology	I	8	Compulsory	
Human Anatomy	I	8	Compulsory	
Mathematics with Elements of Computer Science	I	6	Compulsory	
General and Inorganic Chemistry	II	10	Compulsory	
Physics with Elements of Statistics	II	6	Compulsory	
Pharmaceutical Botany	II	6	Compulsory	
English Language	II	4	Compulsory	
2nd			Compulsory	
Organic Chemistry	I	10	Compulsory	

Human Physiology	I	8	Compulsory
Analytical Chemistry and Complements of General Chemistry with Elements of Nuclear Medicine	I	11	Compulsory
Elective Course (Student's Choice)	I	6	Elective
Drug Analysis with Laboratory	II	10	Compulsory
Microbiology	II	9	Compulsory
Hygiene and Health Management	II	6	Compulsory
3rd			Compulsory
CHEMISTRY OF FOOD AND DIET PRODUCTS WITH NUTRACEUTICAL ELEMENTS	I	8	Compulsory
General pathology and laboratory diagnostics	I	10	Compulsory
GENERAL BIOCHEMISTRY	I	10	Compulsory
Elective course	I	6	Elective
ANALYSIS OF MEDICINAL PRODUCTS I WITH LABORATORY	II	10	Compulsory
PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY I	II	10	Compulsory
4th			Compulsory
GENERAL PHARMACOLOGY AND PHARMACOTHERAPY I	I	8	Compulsory
Pharmaceutical technology and drug regulation	I	14	Compulsory

conventional pharmaceutical forms - Galenic preparation laboratory			
PHARMACEUTICAL AND TOXICOLOGICAL CHEMISTRY II	II	10	Compulsory
ANALYSIS OF MEDICINAL PRODUCTS II WITH LABORATORY	II	10	Compulsory
PHARMACOLOGY AND PHARMACOTHERAPY II	II	10	Compulsory
Practical apprenticeship A	II	15	Compulsory
5th			Compulsory
PHARMACOGNOSY AND PHYTOTHERAPY	I	10	Compulsory
TOXICOLOGY AND PHARMACOVIGILANCE	I	12	Compulsory
Pharmaceutics law and ethics Innovative dosage forms and health products Pharmacy management	II	14	Compulsory
FINAL EXAM	II	14	Compulsory
Practical apprenticeship	II	15	Compulsory
Elective Courses	Semester	ECTS	Elective
COMPLEMENTS OF PHARMACEUTICAL AND TOXICOLOGY CHEMISTRY		6	Elective
FOOD SCIENCE	I	6	Elective
APPLIED BIOCHEMISTRY	I	6	Elective
FARMACOEPIDEMIOLOGIA E FARMACOECONOMIA	I	6	Elective

CLINICAL MICROBIOLOGY	I	6	Elective
APPLIED IMMUNOLOGY	I	6	Elective
APPLIED IMMUNOLOGY 1	I	3	Elective
CELLULAR AND SYSTEMATIC BIOCHEMISTRY	I	6	Elective
CHEMISTRY OF ORGANIC AND NATURAL SUBSTANCES	I	6	Elective
MOLECULAR BIOLOGY	I	6	Elective
CLINICAL PSYCHOLOGY	I	6	Elective
COMMUNICATION PSYCHOLOGY	I	6	Elective
DISCOVERY OF DRUGS AND INNOVATIVE APPROACHES	I	6	Elective
SAFETY OF USE OF NATURAL PRODUCTS	I	6	Elective
CLINICAL EXPERIMENTATION	I	6	Elective
MICROBIOLOGY OF DRUGS AND FOOD	I	6	Elective
Elements of internal medicine	I	6	Elective
Medical devices and advanced therapies: formulation and regulatory aspects	I	6	Elective
LABORATORY MEDICINE AND clinical DIAGNOSTICS	I	6	Elective

Table A10. Course list – University of Rome

Annex XI – University of Padua

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Semester	ECTS		Compulsory	Compulsory
I	12		Compulsory	General and Inorganic Chemistry
I	8		Compulsory	Mathematics and Physics
I	6		Compulsory	Biology (Animal and Plant)
II	6		Compulsory	Human Anatomy
II	3		Compulsory	Computer Science
II	6		Compulsory	Analytical Chemistry
I	10		Compulsory	Biochemistry
I	10		Compulsory	Organic Chemistry
I	6		Compulsory	General Microbiology
II	10		Compulsory	Pharmaceutical Analysis of Drugs I
II	10		Compulsory	Applied Biochemistry
II	8		Compulsory	Pharmaceutical Botany
II	8		Compulsory	Pharmacognosy
II	6		Compulsory	Hygiene
I	10		Compulsory	Pharmaceutical Analysis of Drugs II

I	8	Compulsory	Pharmaceutical and Toxicological Chemistry I
I	10	Compulsory	Pharmaceutical Technology, Socioeconomics, and Regulations I
II	10	Compulsory	Pharmaceutical Analysis of Drugs III
II	6	Compulsory	Pathology
II	8	Compulsory	Physiology
I	8	Compulsory	Pharmaceutical and Toxicological Chemistry II
I	10	Compulsory	Pharmacology and Pharmacotherapy
I	6	Compulsory	Food Chemistry
II	8	Compulsory	Food and Nutrition Science
II	6	Compulsory	Pharmaceutical and Toxicological Chemistry III
II	10	Compulsory	Pharmaceutical Technology, Socioeconomics, and Regulations II
II	8	Compulsory	Chemistry of Make-up Products
II	8	Compulsory	Toxicology
I	4	Compulsory	English Language
I	12	Elective	Elective Courses (Suggested)

II	30	Compulsory	Professional Practice (Internship)
II	15	Compulsory	Final Dissertation
Semester	ECTS	Elective	Elective Courses
I	9	Elective	Pharmaceutical Legislation and Ethics
I	8	Elective	Advanced Pharmaceutical Technology
I	8	Elective	Pharmacoeconomics and Pharmaceutical Management

Table A11. Course list – University of Padua

Annex XII – University of Naples

Course	Semester	ECTS	Type (Compulsory/Elective)	Observations
Semester	ECTS		Compulsory	Compulsory
I	12		Compulsory	GENERAL CHEMISTRY
I	8		Compulsory	PHYSICS
I	6		Compulsory	STATISTICS
II	6		Compulsory	DOCUMENTATION AND SCIENTIFICS METHODOLOGY
II	3		Compulsory	GENERAL BIOLOGY
II	6		Compulsory	
I	10		Compulsory	

I	10	Compulsory	INORGANIC CHEMISTRY
I	6	Compulsory	INSTRUMENTAL TECHNIQUES
II	10	Compulsory	PHYSICAL CHEMISTRY
II	10	Compulsory	PLANT PHYSIOLOGY
II	8	Compulsory	BOTANY
II	8	Compulsory	HUMAN ANATOMY
I	10	Compulsory	BIOCHEMISTRY I
I	8	Compulsory	PHYSIOLOGY I
I	10	Compulsory	ORGANIC CHEMISTRY
II	10	Compulsory	CHEMICAL ANALYSIS
II	6	Compulsory	MICROBIOLOGY
II	8	Compulsory	BIOCHEMISTRY II
I	8	Compulsory	IMMUNOLOGY
I	6	Compulsory	
II	8	Compulsory	
II	6	Compulsory	NUTRITION AND FOOD SCIENCES
II	10	Compulsory	PHYSIOPATHOLOGY
II	8	Compulsory	PHARMACEUTICAL CHEMISTRY
II	8	Compulsory	PHARMACOGNOSY
I	4	Compulsory	

I	12	Elective	CLINICAL NUTRITION
II	30	Compulsory	PHARMACOLOGY I
II	15	Compulsory	PARASITOLOGY
V	6	Elective	
V	6	Elective	MICROBIOLOGICAL AND PARASITOLOGICAL ANALYSES
V	6	Elective	PHARMACEUTICAL MANAGEMENT AND PLANNING

Table A12. Course list – University of Naples