Comparative Analysis Report: Work Package 2 (WP2) - Faculty of Pharmacy, Ss. Cyril and Methodius University in Skopje

Work Package 2: Harmonization of the Core Curriculum for Pharmacy Education and Enhancement of the Internationalization Process

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Prepared for: Erasmus+ Project KA220-HED

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1. Introduction

As part of the Erasmus+ KA220-HED project, Work Package 2 (WP2) is focused on fostering greater alignment and cooperation among several institutions that the staff from the Ss. Cyril and Methodius University in Skopje, Faculty of Pharmacy (North Macedonia), selected to perform comparative analysis and progressive harmonization of pharmacy curricula. The aim of this project is to develop a more coherent and compatible academic framework that facilitates student and staff mobility, supports the creation of a joint or English-taught curriculum, and ensures compliance with European and international standards for pharmacy education among six involved universities: Ss. Cyril and Methodius University in Skopje (North Macedonia), University of Zagreb (Croatia), University of Ljubljana (Slovenia), Medical University of Plovdiv – Faculty of Pharmacy (Bulgaria), Medical University of Warsaw – Faculty of Pharmacy (Poland), and Eastern Mediterranean University (Turkey).

1.1. EU Regulations for the Regulated Profession of Pharmacist

Pharmacy is considered a regulated profession within the European Union, meaning that specific educational and training requirements must be met before a graduate can practice as a pharmacist. These regulations are outlined in EU Directive 2005/36/EC and its amendments (Directive 2013/55/EU), which establish minimum training standards and mutual recognition of qualifications across EU member states.

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

1. **Minimum Duration of Studies:**

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

2. **Practical Training Requirements:**

The directive mandates at least six months of supervised internship in a community or hospital pharmacy, ensuring that students gain hands-on experience before qualifying as pharmacists. 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 complete an accredited pharmacy program in one EU country can have their qualifications recognized in other EU member states under the principle of mutual recognition.

- Pharmacists must meet the host country's language and licensing requirements before practicing.

In the table 1. The comparison of Institutional Compliance with EU Pharmacy Training Standards is given.

Table 1. Comparison of Institutional Compliance with EU Pharmacy Training Standards.

EU Training Standard	Skopje	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)
Minimum 5-year program	Yes	Yes	Yes	Yes	Yes	Yes
Minimum 6-month internship requirement	Yes (10th semester)	Yes (10th semester)	Yes (10th semester)	Yes	Yes	Yes
Mandatory community & hospital training	Yes	Yes	Yes	Yes	Yes	Yes

1.2. Core Subjects in Pharmacy Education

The pharmacy curriculum is structured to provide students with a strong foundation in scientific principles, pharmaceutical knowledge, and clinical skills essential for a successful career in the pharmaceutical sector.

Core subjects represent the fundamental scientific and professional disciplines that all pharmacy students must complete to ensure competency in drug development, patient care, and healthcare systems. The core curriculum typically includes:

1. **Basic Sciences (Preclinical Courses):**
   - Biology, Chemistry (General, Inorganic, Organic), Physics, Biophysics, Applied analytical sciences, Mathematics and Statistics
   - These subjects provide the scientific basis for understanding drug composition, interactions, and mechanisms of action.
2. **Pharmaceutical Sciences:**
   - Pharmaceutical Chemistry, Pharmaceutical Technology, Biopharmacy and Pharmacokinetics and Drug quality control

- These subjects focus on drug formulation, stability, manufacturing, and quality control.

3. **Biomedical and Clinical Sciences:**
   - Anatomy, Physiology, Pathophysiology, Microbiology, Immunology, Pharmacology, Pharmacotherapy & Clinical Pharmacy, Toxicology, Clinical Biochemistry, Food and nutrition, Dietetics etc.
   - These subjects help students understand human diseases, drug action, and safety considerations.
4. **Pharmacy Practice and Professional Courses:**
   - Social Pharmacy, and Pharmaceutical Legislation Pharmaceutical Care & Patient Safety, Public Health & Pharmacoepidemiology
   - These subjects ensure that graduates are competent inpatient counseling, drug regulation, and healthcare policies.

While these subjects are common across all pharmacy programs, the emphasis and distribution may vary between institutions. This report presents a comparative analysis of the core curriculum among the selected Universities, further to identify similarities, differences, and opportunities for harmonization.
The goal is to ensure that students receive a standardized yet flexible pharmacy education, allowing them to pursue professional opportunities across Europe and beyond while meeting the guidelines of the European Higher Education Area (EHEA) and the International Pharmaceutical Federation (FIP).

2. Methodology

The methodology for this comparative analysis was designed to provide a comprehensive and structured approach to examining the pharmacy curricula among all six Universities. The goal was to identify similarities, differences, and areas for harmonization while ensuring alignment with European and international educational standards.

2.1. 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.
3. **Expert Consultations:**
   - Faculty members and academic coordinators from the university that provided the report insights into curriculum implementation, strengths, and challenges.

2.2. Comparative Framework

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

2.2.1. 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, 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.

2.2.2. 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 academic year
- Internship and practical training credits
- Elective course flexibility

2.2.3. 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., pharmaceutical industry, clinical pharmacy, biotechnology, regulatory affairs, alternative medicine)
- The ECTS weight of electives and how they contribute to degree completion

2.2.4. Practical Training and Internship Models

Professional training is a crucial component of pharmacy education. The analysis evaluated:

- The structure and duration of internships
- Opportunities for industry, hospital, and research placements
- Assessment methods used for professional training

2.2.5. Internationalization and Student Mobility

The study reviewed internationalization efforts, particularly:

- Availability of English-taught courses

- Partnerships for student exchanges (Erasmus+, bilateral agreements)

2.3. 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.
  - Internship models were compared by duration, credit value, and setting (hospital, community pharmacy).
- **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.

2.4. 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. Comparative Analysis of Pharmacy

This comparative analysis of pharmacy curricula among the selected Universities, provides insights into the differences and similarities in pharmacy education. Each program follows the European Higher Education Area (EHEA) guidelines, ensuring that students complete an integrated five-year Master's degree (300 ECTS credits) in line with EU Directive 2005/36/EC on the Recognition of Professional Qualifications. However, the structure, course content, elective opportunities, and practical training approaches vary across institutions.

This section examines key curriculum components, including core subjects, credit allocation, elective courses, practical training, and opportunities for specialization.

3.1. General Curriculum Structure and ECTS Credit Distribution

All six universities follow the European Higher Education Area (EHEA) standards for integrated five-year pharmacy programs (300 ECTS), distributed across five academic

years (60 ECTS per year). However, differences arise in the proportion of credits assigned to core subjects, elective courses, and practical training (Table 2).

Table 2. Comparison of ECTS Credit Distribution in Pharmacy Programs Across Selected Universities.

University	Total ECTS	Core Subjects (ECTS)	Elective Subjects (ECTS)	Final Projects (ECTS)	Internships (ECTS)
Ss. Cyril and Methodius University in Skopje	300	246	19	5	30
University of Zagreb	300	287.5	12.5	10	30
University of Ljubljana	300	215	25	30	30
University of Plovdiv	300	253	17	30	/
University of Warsaw	360	306	4	16	30
University of EMU (Turkey)	300	267	18	15	/

Observations on ECTS Distribution:

The University of Zagreb assigns the highest proportion to core subjects (287.5 ECTS), suggesting a curriculum focused on structured, discipline-based instruction with limited flexibility. In contrast, Ljubljana allocates only 215 ECTS to core subjects, reflecting a more modular and interdisciplinary approach that emphasizes elective and research-driven learning. Warsaw (306 ECTS) stands out by exceeding the standard 300 ECTS framework, which may reflect national policies or additional professional competencies required in Poland.

Ljubljana (25 ECTS) and Skopje (19 ECTS) provide the broadest elective scope, encouraging academic flexibility and individual specialization. Warsaw offers only 4 ECTS of electives, suggesting a highly structured curriculum with limited student choice. EMU and Plovdiv offer a moderate number of elective credits (18 and 17 ECTS respectively), though the breadth of course offerings was not uniformly available.

Most universities assign 30 ECTS to full-time internships, typically conducted in the final semester, reinforcing practical pharmacy competencies. Plovdiv and EMU do not explicitly quantify internship credits in their curricula, which could reflect structural integration into other subjects or missing data.

Ljubljana and Plovdiv emphasize academic research, allocating 30 ECTS for the thesis/final project, indicating substantial time dedicated to independent scientific work. Skopje and Zagreb, in contrast, assign only 5 and 10 ECTS respectively, suggesting shorter or less intensive research projects.

3.2. Core Subject Comparison

All six institutions offer courses in basic sciences, pharmaceutical sciences, biomedical and clinical sciences and Professional and Regulatory sciences.

3.2.1. Basic Sciences

These subjects provide a foundational understanding of biology, chemistry, and physics, ensuring students develop strong analytical and problem-solving skills for pharmaceutical applications.

Table 3. Comparison of Basic Science Course Structures in Pharmacy Programs Across Selected Universities.

Discipline/ Course category	Skopje (UKIM)	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)
General & Inorganic Chemistry	8 ECTS (Sem 1)	11 ECTS (Sem 1)	8 ECTS (Sem 1)	7 ECTS (Sem 1)	13 ECTS (I+II)	6 ECTS (Sem 1)
Organic Chemistry	7+10=17 ECTS (Sem 1&2)	11.5 ECTS (Split)	14 ECTS (Split)	10 ECTS (Split)	0 + 6 + 4 = 10 ECTS	10 ECTS (I+II)
Analytical Chemistry	8 ECTS (Sem 2) + 7	7.5 + 6 + 6 = 19.5 ECTS	8 ECTS + Instrumental	6 + 5 = 11 ECTS	0 + 0	4 + 4 = 8 ECTS
Biophysics	6 ECTS (Sem 1)	7.5 ECTS (Sem 1)	—	2.5 ECTS	2 ECTS (Sem 2)	4 ECTS (Physics)
Mathematics	5 ECTS (Sem 1)	7.5 ECTS (Sem 1)	7 ECTS (Sem 1)	4 ECTS	0 + 4	4 ECTS
Statistics	3 ECTS (Sem 2)	—	—	—	3 ECTS	5 ECTS (Biostatistics)
Physics	Included in Biophysics	7.5 ECTS	8 ECTS	3 ECTS	0	4 ECTS (Principles)
Biology / Genetics	6 ECTS (Sem 3)	7.5 + 6 = 13.5 ECTS	7 ECTS (Sem 1)	4 ECTS	4 ECTS (Part I)	5 ECTS

Instrumental Methods	7 ECTS (Sem 3)	Instrumental split	4 ECTS (Sem 5)	6 ECTS (Colloidal incl)	0	—
Pharmaceutical Botany	3 ECTS (Sem 4)	7.5 ECTS (Sem 2)	5 ECTS (Sem 4)	6 ECTS (Split I+II)	6 ECTS (Part I + II)	3 ECTS (Sem 4)

Key Insights from Basic Sciences Course Distribution

1. Chemistry sciences
Chemistry forms the foundation of pharmaceutical education, equipping students with essential knowledge of drug composition, interactions, and chemical properties.

General and Inorganic Chemistry is a foundational subject offered in all six universities. The ECTS allocation varies considerably, from 8 ECTS in Skopje, 11 ECTS in Zagreb, and 8 ECTS in Ljubljana, to 7 ECTS in Plovdiv and a high 13 ECTS in Warsaw (split into two parts). EMU allocates 6 ECTS, reflecting a moderate emphasis. The higher ECTS values in Zagreb and Warsaw suggest more comprehensive theoretical and laboratory components.

Organic Chemistry is taught across all institutions but with structural differences. Skopje, (17 ECTS), Ljubljana (14 ECTS) and Zagreb (11.5 ECTS) offer the most intensive programs, usually split across semesters (1 & 2). Plovdiv spreads organic chemistry over two modules totaling 10 ECTS, as well as Warsaw and EMU organize it across parts I and II (total 10 ECTS). These variations show differing curriculum pacing—some favoring gradual skill building (split modules), others intensive single-semester formats.

Analytical Chemistry is universally represented, but with diverse scope. Skopje (8 + 7 ECTS) and Zagreb (over 19 ECTS total) place strong emphasis on dedicated analytical courses. Ljubljana integrates instrumental methods in a separate course (4 ECTS), while Plovdiv offers two sequential analytical chemistry courses (6 + 5 ECTS). Warsaw and EMU include analytical components with lower visible credit allocation (totaling 8 ECTS in EMU), possibly spread within other modules. This indicates that while all institutions prioritize analysis, the level of specialization differs.

Physical Chemistry is present in all institutions, with Ljubljana (6 ECTS) and Zagreb (7.5 + 6 ECTS) offering robust instruction. Skopje and EMU each allocate 6 ECTS, while Plovdiv and Warsaw combine it with colloidal chemistry or other modules, with total credits varying between 5–6 ECTS.

2. Physics and Biophysics
Physics and Biophysics play a crucial role in pharmacy education, providing students with fundamental knowledge of thermodynamics, fluid dynamics, and molecular interactions essential for drug formulation and delivery.

Ljubljana and Zagreb assign the highest standalone ***Physics*** credits (7.5–8 ECTS), suggesting strong emphasis. Skopje integrates physics within Biophysics (6 ECTS), offering a more biological contextualization. Plovdiv (3 ECTS) and EMU (4 ECTS) offer basic-level physics, while Warsaw does not feature a standalone course in the early semesters.
Biophysics is explicitly present in Skopje, Plovdiv, and Warsaw, but with lower ECTS (2–6), indicating a more supplementary role. Notably, Zagreb and Ljubljana do not label it separately, suggesting integration within other subjects like pharmaceutical sciences or general physics.

3. Biology

Biology is a fundamental component of pharmacy education, providing the scientific basis for understanding drug interactions, disease mechanisms, and human physiology. However, its structure and emphasis differ across the selected Universitates.
Skopje (6 ECTS) and Ljubljana (7 ECTS) consolidate genetics within pharmaceutical biology modules. Zagreb offers a combined “Cell Biology with Genetics” (7.5 ECTS) and an additional 6 ECTS in molecular biology, reflecting the strongest emphasis on biological foundations. Plovdiv (4 ECTS), Warsaw (4 ECTS), and EMU (5 ECTS) provide general courses in biology and genetics, albeit without extensive modularization.

4. Mathematics and statistics

Mathematics and Statistics are key foundational subjects in pharmacy education, providing essential skills for pharmaceutical calculations, data analysis, and research methodology.
Mathematics appears across all institutions except Warsaw, with Ljubljana (7 ECTS), Zagreb (7.5 ECTS), and Skopje (5 ECTS) offering the most robust instruction. Plovdiv and EMU allocate 4 ECTS. The absence of mathematics in Warsaw's visible curriculum may imply integration or de-prioritization.
Statistics is strongest at EMU (5 ECTS) and Zagreb (integrated with math). Skopje (3 ECTS) and Warsaw (3 ECTS) provide statistical education in later semesters. Notably, Ljubljana and Plovdiv do not list statistics explicitly, suggesting indirect instruction or a lower focus on independent statistical methodology.

5. Instrumental Methods in Pharmacy

Instrumental methods in pharmacy education, provide students with the necessary skills for drug analysis, quality control, and pharmaceutical research.

Skopje (7 ECTS, Semester 3) and Ljubljana (4 ECTS, Semester 5) offer clear, standalone courses on instrumental techniques. Zagreb integrates them across several analytical chemistry courses, reflecting a broad but implicit approach. Plovdiv provides Instrumental/Colloidal Chemistry (6 ECTS), while EMU lists Analytical Chemistry II (4 ECTS). Warsaw's curriculum shows no distinct mention of instrumental methods. The alignment in Semester 3 for Skopje and Plovdiv supports early skill acquisition, while other institutions introduce instrumental content later or more diffusely.

3.2.2. Pharmaceutical Sciences

The third and fourth years of pharmacy education focus on advanced pharmaceutical sciences, covering drug formulation, stability, manufacturing, biopharmacy, and quality control. These years are crucial in shaping a student's ability to apply theoretical knowledge in real-world pharmaceutical practices, particularly in drug development, pharmacokinetics, and industrial applications. These courses form the core of pharmacy education (Table 4).

Table 4. Comparison of Pharmaceutical Science Course Structures in Pharmacy Programs Across Selected Universities.

Discipline/ Course category	Skopje (UKIM)	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)
Pharmaceutical Chemistry	30 ECTS (Sem 4–7)	31 ECTS (Sem 5–7)	33 ECTS (Sem 2–6)	21.4 ECTS (Sem 5–6)	20 ECTS (Sem 5–7)	20 ECTS (Sem 5–7)
Pharmaceutical Technology	6+10+8=24 ECTS (Sem 5–7)	3.5 ECTS (Sem 5)	30 ECTS (Sem 3–6)	28.2 ECTS (Sem 5–8)	10 ECTS (Sem 6–8)	15 ECTS (Sem 5–6)
Pharmacognosy & Phytochemistry	20 ECTS (Sem 4–6)	13.5 ECTS (Sem 4–6)	13 ECTS (Sem 5–6)	18.4 ECTS (Sem 6–7)	12 ECTS (Sem 5–6)	13 ECTS (Sem 5–6 + 8 as elective)
Biopharmacy & Pharmacokinetics	7 ECTS (Sem 7)	5 ECTS (Sem 6)	9 ECTS (Sem 7)	10.1 ECTS (Sem 9)	—	8 ECTS (Sem 9)
Pharmaceutical Analysis & Control	7 ECTS (Sem 8)	10.5 ECTS (Sem 7)	8 ECTS (Sem 8)	14 ECTS (Sem 7–8)	7 ECTS (Sem 6)	8 ECTS (Sem 6–8)
Pharmaceutical Biotechnology	3 ECTS (Sem 6)	—	6 ECTS (Sem 7)	—	4 ECTS (Sem 7)	6 ECTS (Sem 5)

Key Insights from Pharmaceutical Sciences Course Distribution

The third and fourth years of pharmacy education focus on advanced pharmaceutical sciences, covering drug formulation, stability, manufacturing, biopharmacy, and quality control. These years are crucial in shaping a student's ability to apply theoretical knowledge in real-world pharmaceutical practices, particularly in drug development, pharmacokinetics, and industrial applications.

1. Pharmaceutical Chemistry
Pharmaceutical Chemistry is a central discipline, with strong representation across all six universities. Most institutions divide the subject into multiple levels to gradually build student competency. Ljubljana offers the highest allocation (33 ECTS), taught from Semester 2 to 6, indicating an early and continuous progression. Zagreb (31 ECTS) and Skopje (30 ECTS) deliver it across three levels from Semester 4 to 7. Plovdiv, Warsaw, and EMU each offer around 20–21 ECTS, typically from Semesters 5 to 7, demonstrating a moderately intensive structure. The modularity in Ljubljana and Zagreb reflects curriculum designs emphasizing longitudinal competency development. Warsaw and EMU include multiple modules, sometimes paired with stability and control elements (e.g., "Stability of Medicinals").

2. Pharmaceutical Technology
Pharmaceutical Technology varies significantly across institutions in terms of credit load and structure. Ljubljana (30 ECTS), Plovdiv (28.2 ECTS) and Skopje (24 ECTS) show the most extensive implementation, with multi-part modules covering fundamental and advanced manufacturing principles from Semesters 3 to 8. EMU (15 ECTS) and Warsaw (10 ECTS) provide a concise but structured offering. Zagreb lists only 3.5 ECTS, suggesting that practical aspects of formulation may be integrated into pharmaceutical chemistry or elective blocks. Advanced modules, such as Industrial Pharmacy (Warsaw) and Simulations in Pharmacy Practices (EMU), enhance hands-on competencies for industrial applications, preparing students for real-world manufacturing roles.

Pharmaceutical Biotechnology is gaining importance as biopharmaceuticals and personalized therapies expand globally. Ljubljana (6 ECTS, Semester 7) and EMU (6 ECTS, Semester 5) present full standalone biotechnology modules. Skopje includes a 3 ECTS course in Semester 6 titled "Fundamentals of Pharmaceutical Biotechnology." Warsaw offers 4 ECTS in Semester 7, while Zagreb and Plovdiv do not explicitly mention biotechnology, suggesting integration into other courses or potential elective offerings. EMU also complements this with cell culture and simulation modules, indicating a strong practical orientation in applied biosciences.

3. Biopharmacy & Pharmacokinetics
These subjects are critical for understanding drug absorption, bioavailability, and therapeutic design. Plovdiv allocates the highest load (10.1 ECTS, Semester 9), followed by Ljubljana (9 ECTS, Sem 7) and EMU (8 ECTS, Sem 9). Skopje (7 ECTS) and Zagreb (5 ECTS) offer moderate but targeted coverage, typically in the later stages of study.

Notably, Warsaw does not list a dedicated Biopharmacy course, possibly integrating this content into Pharmacology or Pharmaceutical Technology. These later-semester placements align with advanced therapeutic modules, enabling students to contextualize pharmacokinetic principles in real-world settings.

4. Phytotherapy & Herbal Drugs

Courses in herbal drugs and phytotherapy are broadly represented but differ in emphasis. Skopje places strong emphasis with 20 ECTS, distributed across Pharmacognosy, Phytochemistry, and Basics of Phytotherapy. Plovdiv (18.4 ECTS) and Zagreb (13.5 ECTS) offer multi-semester instruction, emphasizing both identification and pharmacological aspects of herbal materials. Ljubljana, Warsaw, and EMU offer between 12–13 ECTS, generally divided into Pharmacognosy I and II with occasional phytotherapy electives (EMU: Semester 8). Skopje is unique in dedicating separate core modules to Phytochemistry (Semester 4, 7 ECTS) and Phytotherapy (Semester 6), highlighting its commitment to natural product education.

5. Pharmaceutical Analysis

Pharmaceutical Analysis ensures students acquire critical competencies for regulatory compliance, product validation, and quality control. Plovdiv leads with 14 ECTS across two modules, followed by Zagreb (10.5 ECTS) and Ljubljana (8 ECTS). These universities provide a standalone analytical focus, often including drug testing and legislation. Skopje (7 ECTS, Semester 8) integrates analytical methods with regulatory content in a course titled “Analysis of Drugs and Legislation.” EMU and Warsaw also offer independent analytical modules (8 and 7 ECTS respectively), reflecting balanced instruction between theoretical and applied quality control.

3.2.3. Biomedical and Clinical Sciences Distribution

3.2.3.1. Biomedical sciences

Biomedical sciences form a critical component of pharmacy education, providing students with a strong foundation in human biology, physiology, pathology, microbiology, and clinical chemistry. These subjects help students understand disease mechanisms, drug interactions, and the biological basis of pharmaceutical interventions. A comparative analysis across six pharmacy programs reveals distinct approaches to subject grouping, credit allocation, and progression across semesters.

Table 5. Comparison of Biomedical Sciences Subject Distribution and ECTS Allocation Across Selected Institutions.

Discipline/ Course category	Skopje	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)

Anatomy & Histology / Physiology	Anatomy & Physiology (10 ECTS, Sem 4)	Physiology & Anatomy (9 ECTS, Sem 4)	Anatomy & Histology (4, Sem 2); Physiology (6, Sem 3)	Human Anatomy (3.8, Sem 2); Human Physiology (6, Sem 3)	Human Anatomy (2, Sem 1); Physiology (5, Sem 3)	Anatomy & Histology (3, Sem 2); Physiology I & II (5+4, Sem 3–4)
Biochemistry	6 ECTS (Sem 3)	8.5 ECTS (Sem 4)	Pharmaceutical Biochem. (7, Sem 4)	Biochemistry I+II (3+4, Sem 3–4)	Biochemistry (6, Sem 4)	Biochemistry (6, Sem 4)
Microbiology	7 ECTS (Sem 3)	Microbiology & Parasitology (8, Sem 4)	Microbiology (4, Sem 2)	Microbiology + Virology (4+4, Sem 4–5)	Microbiology (5, Sem 4)	Pharm. Microbiology I+II (5+5, Sem 3–4)
Immunology	Fundamentals of Immunology (3, Sem 4)	Immunology (2.5, Sem 8)	—	Immunology (3, Sem 4)	Immunology (3, Sem 4)	Immunology (4, Sem 4)
Pathology / Pathophysiology	Pathophysiology (6, Sem 5)	Pathophysiology & Pathology (7.5, Sem 5)	Pathophysiology (6, Sem 5)	Pathoanatomy (3) + Pathophysiology (2), Sem 4–5	Pathophysiology I+II (4 + 6.1, Sem 5 & 9)	Pathology (2, Sem 4); Pathophysiology (4, Sem 5)
Nutrition / Dietetics	Food and Dietetics (5, Sem 7)	Nutrition (5, Sem 6)	—	—	—	

Key Insights from Biomedical Sciences Distribution

1. Human Anatomy & Physiology

Anatomy and Physiology are introduced early and represent the cornerstone of biomedical training in all programs. Skopje offers a single, integrated "Anatomy and Physiology" course (10 ECTS, Semester 4), which is among the most intensive offerings across all institutions. Zagreb combines these fields into “Physiology and Human Anatomy” (9 ECTS, Semester 4), while Ljubljana separates them, introducing Anatomy and Histology (4 ECTS, Sem 2) and Physiology (6 ECTS, Sem 3). Plovdiv teaches Human Anatomy and Physiology in separate courses (3.8 and 6 ECTS), indicating a moderate

workload with potential for spaced learning. Warsaw introduces Human Anatomy (2 ECTS) in the first semester and Physiology (5 ECTS) in the third semester, a unique early placement strategy. EMU divides Physiology into two parts (5 + 4 ECTS in Sem 3 and 4), ensuring a gradual and comprehensive understanding.

2. Pathophysiology & Disease Mechanisms

These courses are fundamental for understanding clinical implications of drug treatment and disease progression. Skopje offers Pathophysiology (6 ECTS, Sem 5), preceded by Fundamentals of Immunology (3 ECTS). Zagreb combines pathology and pathophysiology in Semester 5 (7.5 ECTS), allowing an integrated understanding of disease states. Ljubljana (6 ECTS) and Plovdiv (4 + 2 ECTS) teach pathophysiology in the mid-program period. Warsaw follows a two-part structure (4 ECTS in Sem 5 and 6.1 ECTS in Sem 9), showing progressive complexity. EMU includes Pathology (2 ECTS) early, followed by progressive Pharmacology–Pathophysiology integrations.

3. General Biochemistry

Biochemistry bridges biological and chemical sciences, critical for understanding enzymatic reactions, metabolism, and drug mechanisms. Zagreb (8.5 ECTS, Sem 4) and Skopje (6 ECTS, Sem 3) offer high ECTS allocations, with early placements. Ljubljana divides the subject into Pharmaceutical Biochemistry (7 ECTS, Sem 4), while Plovdiv splits it between Biochemistry I and II (3 + 4 ECTS). Warsaw (6 ECTS) and EMU (6 ECTS) maintain similar coverage, typically offered in Semesters 3 or 4.

4. Microbiology / Parasitology

Understanding infectious agents and the immune response is essential for drug targeting and antimicrobial therapy. Skopje (7 ECTS, Sem 3) and Zagreb (8 ECTS, Sem 4) offer the most extensive Microbiology modules, while Ljubljana includes 4 ECTS (Sem 2). Plovdiv covers Microbiology and Virology in two parts (4 + 4 ECTS), reinforcing theoretical and practical learning. Warsaw includes Microbiology in Semester 4 (5 ECTS) and Immunology (3 ECTS) in the same semester, ensuring integration with pathology courses. EMU spreads Microbiology over two modules (5 + 5 ECTS) and pairs it with Immunology (4 ECTS, Sem 4), offering the most structured immunological exposure among the six institutions.

5. Immunology

Though smaller in credit value, immunology complements microbiology and pathophysiology. Skopje (3 ECTS, Sem 4), Plovdiv (3 ECTS), and Warsaw (3 ECTS) provide uniform credit. Zagreb offers 2.5 ECTS (Sem 8), while EMU gives 4 ECTS (Sem 4), the most among peers. Ljubljana does not list immunology as a standalone subject.

6. Food and Nutrition: Differences in Course Structure and Emphasis

This subject links biomedical science with lifestyle-based interventions. Skopje introduces Food and Dietetics (5 ECTS, Sem 7), with emphasis on clinical integration. Zagreb offers Nutrition (5 ECTS, Sem 6), possibly more preventive in nature. EMU presents it early (3 ECTS, Sem 2), giving students dietary foundations alongside physiology.

3.2.3.2. Clinical sciences

Clinical subjects are a vital component of pharmacy education, equipping students with the knowledge and skills needed for patient-centered care, pharmacotherapy, and clinical decision-making. These courses focus on drug therapy management, disease treatment, medication safety, and healthcare collaboration, ensuring that pharmacy graduates can effectively contribute to patient care, hospital pharmacy, and community health services (Table 6).

Table 6. Comparison of Clinical Subjects Distribution Across Institutions.

Discipline / Course category	Skopje	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)
Pharmacology	Fundamentals of Pharmacology (6, Sem 5)	Pharmacology (10.5, Sem 7)	Pharmacology (5, Sem 7)	Pharmacology I+II (6 + 6.2, Sem 5–6)	Pharmacology I–III (4+4+4, Sem 5–7)	Pharmacology I–III (4+4+4, Sem 5–7)
Toxicology	Toxicology (9, Sem 8)	Toxicology (5, Sem 8)	—	Toxicology (6, Sem 7)	Toxicology (4, Sem 6)	Toxicology (4, Sem 6)
Clinical Biochemistry	Clinical Biochem. (7, Sem 8)	Clinical Biochem. (6, Sem 6)	Clinical Chemistry (7, Sem 8)	Clinical Chemistry (4, Sem 5)	Clinical Biochem. (4, Sem 8)	Clinical Biochem. (4, Sem 8)
Clinical Pharmacy & Therapeutics	Intro. to Clinical Pharm. (4, Sem 8); Clinical Pharm. & Therapeutics (10, Sem 9)	Clinical Pharmacy & Pharmacotherapy (6, Sem 8); Pharmaceutical Care (5, Sem 9)	—	Clinical Pharmacy (5, Sem 7); Pharmacotherapy I–II (6 + 6.1, Sem 8–9)	Clinical Pharmacy (3, Sem 9); Pharmacotherapy I–II (5+5, Sem 8–9)	

Key Insights from Clinical Subjects Distribution

1. Pharmacology
Pharmacology is central in clinical training and is consistently well-represented. Skopje offers “Fundamentals of Pharmacology” (6 ECTS, Sem 5). Zagreb provides a high-load course (10.5 ECTS, Sem 7) for deep drug action training. Ljubljana and Warsaw split it across three modules (12 ECTS total, Sem 5–7). Plovdiv and EMU also divide the course into Part I and II, offering 12.2 and 12 ECTS, respectively.

2. Pharmacotherapy & Clinical Pharmacy
These are capstone subjects, integrating pharmaceutical knowledge into clinical practice. Skopje provides the most comprehensive structure: “Introduction to Clinical Pharmacy” (4 ECTS, Sem 8) and “Clinical Pharmacy and Therapeutics” (10 ECTS, Sem 9). Zagreb delivers Clinical Pharmacy and Pharmacotherapy (6 ECTS, Sem 8) and Pharmaceutical Care (5 ECTS, Sem 9). Plovdiv has Clinical Pharmacy (5 ECTS, Sem 7), followed by Pharmacotherapy I–II (12.1 ECTS total, Sem 8–9). Warsaw splits Pharmacotherapy I–II (10 ECTS total) with Clinical Pharmacy (3 ECTS, Sem 9), offering a compact yet complete structure.

3. Toxicology
Toxicology is essential for understanding adverse drug reactions and poison management. Skopje (9 ECTS, Sem 8) offers the highest credit among all. Zagreb (5 ECTS, Sem 8) and Plovdiv (6 ECTS, Sem 7) also maintain strong standalone instruction. Warsaw and EMU provide 4 ECTS courses (Sem 6), reflecting a more condensed delivery.

4. Clinical Biochemistry
This subject applies biochemical concepts to diagnostics and patient monitoring. Skopje (7 ECTS, Sem 8) and Ljubljana (7 ECTS, Sem 8) offer deep coverage late in the program. Zagreb (6 ECTS, Sem 6) introduces it slightly earlier. Plovdiv, Warsaw, and EMU offer 4 ECTS courses, placed in Semester 5 or 8, suggesting a supportive role to core clinical disciplines.

5. **Pharmaceutical Care**
Pharmaceutical Care emphasizes patient-centered pharmacy and interprofessional collaboration. Zagreb offers it as an elective (3 ECTS, Sem 9). València and EMU integrate it within broader Clinical Pharmacy modules (6 ECTS, Sem 9). Skopje does not include Pharmaceutical Care as a standalone subject, although aspects may be embedded within Clinical Pharmacy.

3.2.4. Professional and Regulatory Courses Distribution

Professional and regulatory courses play a crucial role in preparing pharmacy graduates for real-world practice, ensuring they understand pharmaceutical laws, patient care responsibilities, ethics, and business aspects of the pharmacy profession. These courses equip students with the knowledge required to navigate regulatory frameworks, drug approval processes, and healthcare policies while fostering patient-centered pharmaceutical care.

Table 7. Comparison of Professional and Regulatory Courses Across Institutions.

Discipline/ Course category	Skopje	Zagreb	Ljubljana	Plovdiv	Warsaw (MUW)	EMU (Turkey)
Intro to Pharmacy & Informatics	Introduction to Pharmacy (2, Sem 1)	Introduction (1.5, Sem 1)	Pharmaceutical Informatics (5, Sem 2)	Information Technology (2.5, Sem 2)	History of Pharmacy (1, Sem 1)	Public Health (2, Sem 3)

Literature Evaluation / Evidence-based Practice	Evaluation of Scientific Lit. (2, Sem 1)	Sociology & Health Care (2.5, Sem 2)	Introduction to Pharmacy (3, Sem 2)	Hygiene & Ecology (3, Sem 5)	Hygiene & Epidemiology (2, Sem 3)	History & Ethics of Pharmacy (1, Sem 5)
Social Pharmacy	Social Pharmacy (3, Sem 5)	Pharmacy Practice I (2, Sem 6)	Social Pharmacy (4, Sem 5)	Epidemiology (2, Sem 7)	Pharmaceutical Law & Ethics (3, Sem 7)	Pharmacoeconomics (3, Sem 6)
Ethics and Legislation	Ethics & Legislation (3, Sem 6)	Pharmacy Practice II (3, Sem 8)	—	Social Pharmacy & Legislation I (5, Sem 8)	Pharmacoeconomics (3, Sem 7)	Hospital Pharmacy Applications (2, Sem 7)
Informatics / Pharmacoinformatics	Pharmacoinformatics (3, Sem 8)	Prescription Pharmacy (3.5, Sem 8)	—	Medicinal Devices (4, Sem 8)	Hospital Pharmacy (5, Sem 8)	Community Pharmacy Applications (2, Sem 7)
Professional Communication / Law / Ethics	—	Comm. Skills, Law, Ethics (Sem 9)	—	Social Pharmacy & Legislation II (7.7, Sem 9)	Pharmaceutical Care (4, Sem 8)	Pharmaceutical Care (1, Sem 10)
Pharmacy/Hospital Clerkships	—	—	—	—	Clerkship (Sem 11–12): 8+8+10+10 ECTS	

Key Insights from Course Distribution

1. **Introduction to Pharmacy and Informatics**

   Early orientation to the pharmacy profession is a common feature: Skopje, Zagreb, and Ljubljana introduce students to pharmacy principles between Semesters 1–2. Ljubljana adds significant emphasis through Pharmaceutical Informatics (5 ECTS, Sem 2). Warsaw and EMU embed this through History of Pharmacy and Public Health, while Plovdiv includes Information Technology.

2. **Evidence-Based and Social Pharmacy**

   Skopje and Ljubljana place Social Pharmacy in Semester 5 with 3–4 ECTS. Plovdiv expands this into two multi-part courses covering Epidemiology and Social Pharmacy with legislation, reaching 7.7 ECTS. Warsaw includes Hygiene & Epidemiology (2 ECTS) and Pharmaceutical Law & Ethics (3 ECTS) by Semester 7, while EMU introduces Pharmacoeconomics early (Sem 6) and progressively adds modules on health systems.

3. **Pharmaceutical Ethics, Law, and Legislation**

   Skopje and Ljubljana incorporate ethics in Semesters 6–8, with Pharmacoinformatics in Semester 8 (3 ECTS). Plovdiv builds a comprehensive two-part series: Social Pharmacy and Pharmaceutical Legislation I & II, summing up to 12.7 ECTS. Warsaw covers ethics and legal matters in combination with Pharmaceutical Law, while EMU offers Pharmaceutical Care and Hospital/Community Practice Applications.

4. **Patient Care, Communication and Clerkships**

   Zagreb includes Communication Skills, Health Legislation, and Deontology (all 1.5 ECTS in Sem 9), showing emphasis on professional skills development. EMU and

Warsaw have the most detailed clerkship systems, beginning in Semester 11 and continuing into Semester 12 with multiple modules: Hospital Pharmacy Clerkship (10 ECTS) and Community Pharmacy representing a structured integration into real-world pharmacy practice.

Distribution of ECTS Credits Among Four Main Areas in the Pharmacy Curriculum Across Investigated Faculties

Pharmacy education within Europe demonstrates considerable variability based on institutional focus, national healthcare priorities, and intended graduate outcomes. By examining the curricula of Ss. Cyril and Methodius University in Skopje, University of Zagreb, University of Ljubljana, Medical University of Plovdiv, Medical University of Warsaw, and Eastern Mediterranean University (EMU) in Turkey, we can observe how each program distributes its ECTS credits across four core subject areas.

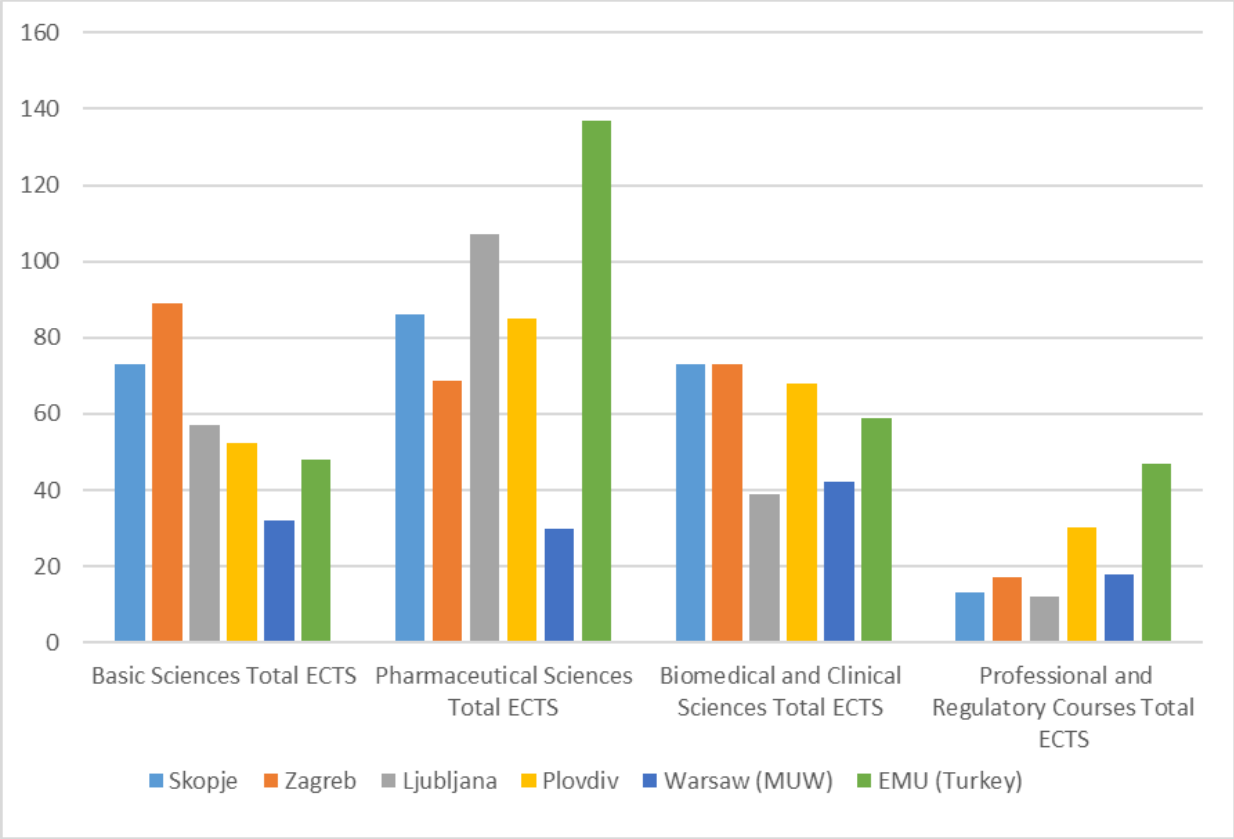

Figure 1. ECTS distribution across core subject categories in the pharmacy programs of the selected Universities.

Figure 1. visually compares the ECTS credit distribution across key subject categories in the pharmacy programs of six Universities It highlights the varying emphasis each institution places on basic sciences, pharmaceutical sciences, biomedical sciences, clinical sciences, and professional & regulatory sciences, showcasing the differences in curriculum structure and focus.

1. Basic Sciences

Basic sciences form the scientific foundation of pharmacy education and include general, inorganic, and organic chemistry; biology; mathematics; physics; statistics; and biophysics. These courses typically appear in the early semesters and underpin further learning in drug design, pharmacokinetics, and toxicology.
Zagreb (89 ECTS) and Skopje (73 ECTS) assign the greatest weight to basic sciences, ensuring robust early training in scientific principles. Ljubljana (57 ECTS) and EMU (48 ECTS) allocate fewer credits, suggesting that some content may be integrated within later applied or interdisciplinary courses. Warsaw (32 ECTS) offers the least ECTS in this category, likely indicating a greater emphasis on integrated and clinically contextualized learning rather than extended foundational modules.

2. Pharmaceutical Sciences

This domain includes pharmaceutical chemistry, technology, pharmacognosy, biopharmacy, drug formulation, phytotherapy, and quality control. It represents the technological and scientific competencies needed for drug development, manufacturing, and evaluation.
EMU (137 ECTS) places the strongest focus on pharmaceutical sciences, suggesting a curriculum geared toward industry readiness and formulation science. Ljubljana (107 ECTS) and Skopje (86 ECTS) also show a strong commitment to laboratory and formulation sciences. Zagreb (68.5 ECTS) and Warsaw (30 ECTS) allocate the least, which may indicate greater curricular space reserved for biomedical and clinical instruction.

3. Biomedical & Clinical Sciences
Courses in this domain—anatomy, physiology, microbiology, biochemistry, immunology, pathology, pharmacology, toxicology, clinical pharmacy, and pharmacotherapy—form the biological and therapeutic core of the profession.
Skopje (73 ECTS) and Zagreb (73 ECTS) provide the most balanced coverage, ensuring a strong connection between science and patient-oriented practice. Ljubljana (39 ECTS) devotes substantially less space, possibly due to stronger integration of therapeutic content in pharmaceutical courses. Warsaw (42 ECTS) and EMU (59 ECTS) present intermediate approaches, likely tailored for preparing students for hospital or clinical roles.

4. Professional and Regulatory Sciences

These include social pharmacy, communication skills, pharmaceutical legislation, ethics, public health, pharmacoepidemiology, and pharmaceutical care. They support professional identity, patient safety, and healthcare integration. EMU (47 ECTS) allocates the highest number of credits, signaling a program highly focused on patient engagement, professional development, and real-world skills. Plovdiv (30.3 ECTS) and Warsaw (18 ECTS) also emphasize this area through standalone practice modules. Skopje (13 ECTS) and Ljubljana (12 ECTS) offer the least, suggesting integration within broader subjects or a stronger research/technical orientation.

3.2.5. Final degree project

The final degree project allows students to synthesize their academic knowledge through independent research and thesis development. Significant variation exists in how university's structure and credit this component, reflecting institutional emphasis on research skills, project duration, and assessment formats. University of Ljubljana provides the most research-intensive structure, allocating 25 ECTS for Individual Research Work for the Master's Thesis and 5 ECTS for its Defense, both in semester 9—demonstrating a consolidated focus on early, intensive research engagement. Plovdiv dedicates the entire 30 ECTS in semester 10 to a unified Thesis, indicating a high-level, semester-long commitment to the final project. University of Zagreb grants 10 ECTS for a Diploma Thesis in semester 9, placing moderate emphasis on independent work compared to more extensive projects in Ljubljana and Plovdiv. Medical University of Warsaw distributes the workload across Master's Thesis Preparation (6 ECTS, semester 9) and Defense (10 ECTS, semester 10), totaling 16 ECTS. Eastern Mediterranean University adopts a scaffolded thesis model with Thesis Projects I–III across three semesters (9–11), allocating 15 ECTS in total (3+6+6). Ss. Cyril and Methodius University in Skopje has the most modest thesis load (5 ECTS, semester 9), indicating a more limited scope for individual research, potentially embedded within broader coursework. Overall, institutions such as Ljubljana and Plovdiv prioritize intensive research experiences through higher ECTS allocations, while Skopje and Eastern Mediterranean University offer more limited or distributed thesis structures.

3.3. Elective Course Flexibility

Elective courses represent a vital component of modern pharmacy curricula, serving as a bridge between standardized core training and personalized academic exploration. These courses empower students to shape their educational pathway according to professional goals, academic interests, and emerging pharmaceutical trends. In addition to enhancing student engagement, elective offerings also reflect each institution's pedagogical philosophy and areas of academic strength.

3.3.1. Comparison of Elective Course Distribution

Table 8 outlines a comparative summary of elective course distribution across selected pharmacy programs in Europe, focusing on the total ECTS credits allotted, the number of

electives required in the study plan, the breadth of elective subjects offered, and the semesters in which electives are available.

Table 8. Comparative Analysis of Elective Course Distribution in Pharmacy Programs Across Selected Universities.

University	Total Elective ECTS	Number of Elective Subjects in study plan (1)	Number of Elective offered (2)	Ratio (2)/(1)	Semesters Offering Electives
Skopje	19 ECTS	5	23	4.6	6th and 9th
Zagreb	20 ECTS	4	15	8	7th, 8th, 9th and 10th
Ljubljana	25 ECTS	5	26	5.2	6th, 7th and 8th
Plovdiv	20 ECTS	13	/	/	2th, 3th, 4th, 5th, 7th, 8th and 9th
Warsaw (MUW)	8 ECTS	2	/	/	8th and 10th
EMU (Turkey)	18 ECTS	4	/	/	6th, 9th, and 10th

Ljubljana – stands out with the highest total elective ECTS (25) and 26 subjects offered, resulting in a favorable choice ratio of 5.2. Electives are distributed across three mid-to-late semesters (6th to 8th), providing sustained exposure to interdisciplinary topics during key professional development phases.
Zagreb – features a compact system: only 4 electives required, but 15 options available, yielding the highest choice ratio (8.0). Electives are evenly spread from the 7th through the 10th semester, facilitating late-stage specialization while balancing core responsibilities.
Skopje - offers 5 electives totaling 19 ECTS, with a relatively wide offering of 23 electives (ratio 4.6). However, elective availability is restricted to only two semesters (6th and 9th), limiting continuous exploration or thematic progression. A broader distribution across semesters would enhance flexibility and allow students to refine focus over time.
Warsaw (MUW) and EMU (Turkey) – provides just 8 ECTS across 2 electives, offered in the final years (8th and 10th semesters). However, the number of options is not specified, suggesting a potentially narrow scope or unstructured offering.
EMU allocates a respectable 18 ECTS over 4 electives, but again lacks clarity on the number and diversity of subjects. Nevertheless, the multi-semester span (6th, 9th, 10th) implies moderate flexibility.
Plovdiv integrates 13 elective courses throughout the curriculum, contributing 20 ECTS in total. While the number of electives offered (i.e., available for selection) is not specified, the program demonstrates broad distribution, with electives appearing in seven different semesters—more than any other university in this comparison.
Elective systems vary significantly in both scope and structure. While some universities (e.g., Zagreb and Ljubljana) emphasize broad elective engagement and semester-wide distribution, others (e.g., Skopje and Warsaw) offer a narrower window of choice.

3.3.4. Alignment with European and International Standards

Elective courses play a crucial role in aligning pharmacy education with European Higher Education Area (EHEA) and International Pharmaceutical Federation (FIP) standards.

These organizations emphasize:

1. Interdisciplinary learning opportunities (e.g., combining pharmaceutical sciences with public health or regulatory affairs).
2. Flexibility in curriculum to accommodate diverse career pathways (e.g., industrial pharmacy, clinical pharmacy, biotechnology).
3. Internationalization and mobility through elective courses that allow students to engage in exchange programs.

3.4. Internships

Internships and structured practical training are essential components of pharmacy education, ensuring that students acquire hands-on experience in pharmaceutical settings. All analyzed institutions, with the exception of Eastern Mediterranean University, provide a 30 ECTS internship or pre-registration training period, typically in the final year of studies. These placements support the development of clinical, technical, and regulatory skills essential for professional readiness.
Despite similar credit allocations among most institutions, the semester timing and naming conventions reflect national differences in internship structure and integration. Nonetheless, the universal commitment to 30 ECTS confirms the shared understanding of the importance of experiential learning in pharmacy education.

3.4.1. Comparison of Internship Structures Across Universities

Table 11. Comparison of Professional internship Across Selected Universities.

U**niversity**	**Total Internship & Practical Training ECTS**	**Structure & Duration**
Skopje	30 ECTS (10th semester)	Full-time professional internship (6 months) in community or hospital pharmacy
Zagreb	30 ECTS (10th semester)	Full-time professional internship
Ljubljana	30 ECTS (9th semester)	Full-time professional internship
Plovdiv	30 ECTS (/ semester)	Full-time professional internship
Warsaw (MUW)	30 ECTS (10th semester)	Full-time professional internship
EMU (Turkey)	/	/

Skopje, Zagreb, Ljubljana, and Warsaw (MUW) all allocate 30 ECTS to a full-time professional internship, usually undertaken in the final semester of the program. These internships typically span five to six months, providing immersive experience in both community and hospital pharmacy environments. This standardization in ECTS allocation

reflects compliance with EU Directive 2013/55/EU, which mandates a six-month traineeship under the supervision of a qualified pharmacist.
Among all programs, Skopje's internship (10th semester, 30 ECTS) is particularly well-structured for practical application. It offers a six-month continuous training period, giving students sufficient time to apply clinical, regulatory, and pharmaceutical sciences knowledge in real-life patient care settings. The alignment with post-graduate workforce demands enhances employability and readiness for professional licensure.
Ljubljana places the internship in the 9th semester, which could offer earlier integration into professional settings but may compress thesis completion or elective coursework into the final semester. Plovdiv does implement a full-time internship, with 30 ECTS. Similarly, EMU (Turkey) does not clearly present a structured internship or indicate its ECTS contribution, suggesting a need for greater transparency or possible integration within other modules.

3.5. Internationalization and Student Mobility

In an increasingly globalized pharmaceutical sector, internationalization and student mobility play a vital role in ensuring pharmacy graduates are equipped for international careers. This study examines the internationalization efforts of all Universities, focusing on English-taught programs and student exchange opportunities through Erasmus+ and bilateral agreements (Table 12).

Table 12. Mobility & Collaboration Features Summary.

University	Erasmus+	Bilateral Agreements	English-Taught Program	Research/Joint Projects
Skopje	✔ Yes	✔ Moderate	✗ No (Macedonian only)	✔ In development
Zagreb	✔ Yes	✔ Yes	✔ Full English Program	✔ Moderate
Ljubljana	✔ Yes	✔ Extensive	✔ Some electives	✔✔ Active participation
Plovdiv	✔ Yes	✔ Limited	✔ Full English Program	✔ Growing
Warsaw (MUW)	✔ Yes	✔ Moderate	✔ Partial availability	✔ Moderate

EMU (Turkey)	✔ Yes	✔✔ Extensive	✔ Full English Program	✔✔ Strong engagement

All six universities (Skopje, Zagreb, Ljubljana, Plovdiv, Warsaw (MUW), and EMU (Turkey)) participate in the Erasmus+ program. These exchanges improve intercultural competencies, academic flexibility, and employability, and help align programs with European Higher Education Area (EHEA) standards.

3.5.1. Bilateral Agreements and Institutional Partnerships

Most faculties have signed bilateral agreements beyond Erasmus+ (especially EMU and Ljubljana), fostering: Joint research projects, Shared teaching staff, Co-supervision of theses, Collaborative workshops and conferences.

3.5.2. English-Taught Courses and Programs

EMU, Plovdiv and Zagreb, offer full English-taught pharmacy programs, significantly improving access for foreign students and international collaboration.

Ljubljana and Warsaw (MUW) offer selected modules or electives in English, especially in later semesters or for exchange students.

Skopje is still largely taught in national languages but accept Erasmus students, often with tailored support or project-based integration.

3.5.3. Joint Programs, Summer Schools, and Research Mobility

Some universities (notably Ljubljana, Zagreb, and EMU) participate in:

- Joint master's or research mobility programs under Erasmus Mundus or Horizon Europe
- Summer/winter schools on pharmaceutical topics (e.g., biotechnology, pharmacoeconomics)
- International clinical training placements in hospital or community settings

These initiatives encourage international specialization and promote institutional excellence through knowledge-sharing.

4. Recommendations for Harmonization

To ensure greater alignment and mobility among pharmacy students across Skopje, Belgrade, and València, the following harmonization strategies are recommended:

1. Aligning Core Curricula and Credit Allocation
   Ensure that all programs consistently include:
   - Basic sciences (chemistry, biology, physics, math) in the first two years
   - Pharmaceutical technology, pharmacology, pharmacognosy, and biopharmacy by mid-program
   - Clinical pharmacy, pharmacotherapy, and legislation in the final years
   - Use a modular approach with transparent ECTS allocation across all five key subject areas.
2. Enhancing Flexibility in Electives and Specializations
   - Introduce elective courses earlier in the curriculum (before the final year) to allow students to tailor their learning experiences and develop expertise in specialized areas.
   - Recommend at least 20 ECTS of electives, offered across minimum 3 semesters, with choice ratios ≥ 4.0.
3. Standardizing Internship Structures and Practical Training
   - Ensure all programs implement a 30 ECTS (6-month) internship in the final year, in either community or hospital pharmacies.
   - Develop shared internship evaluation templates and core learning outcomes across institutions.
4. Harmonize Thesis & Final Project Expectations
   - Agree on a standard workload (10–15 ECTS) for the master's thesis or final project.
   - Encourage joint thesis supervision and mobility-based research under Erasmus+, Horizon Europe, or bilateral frameworks.
5. Strengthening Internationalization and Mobility
   - Increase the availability of English-taught courses to enhance mobility and accessibility for international students.
   - Create shared exchange programs where students can complete internships or coursework at a partner institution without credit transfer issues.
   - Develop a common European competency framework for pharmacy graduates, ensuring that qualifications are recognized across borders without the need for additional certification.

5. Conclusions

This comparative analysis of pharmacy curricula at Ss. Cyril and Methodius University in Skopje, University of Zagreb, University of Ljubljana, Medical University of Plovdiv, Medical University of Warsaw (MUW), and Eastern Mediterranean University (EMU) reveals both alignment with European pharmacy training standards and key structural variations across institutions.

All six faculties comply with the European Higher Education Area (EHEA) framework and adhere to the core principles of EU Directive 2005/36/EC, ensuring a 5-year integrated Master's program (300 ECTS) with adequate practical training. Each curriculum provides students with foundational competencies in basic sciences, pharmaceutical sciences, biomedical and clinical subjects, as well as exposure to professional ethics, regulation, and public health.

Despite this common framework, notable differences exist in:

- Credit distribution across subject categories (e.g., basic vs. clinical sciences),
- Internship structures and durations,
- Thesis workload (ranging from 5 to 30 ECTS),
- And flexibility in elective course offerings.

Institutions like Ljubljana and EMU prioritize research and pharmaceutical technology, while Warsaw and Plovdiv place stronger emphasis on clinical and biomedical sciences. Zagreb maintains a highly structured, core-heavy curriculum, whereas Skopje offers a more balanced yet traditionally structured program.

To foster greater harmonization, it is recommended that faculties:

- Align internship duration and credit loads (minimum 6-month practice),
- Ensure balanced credit allocation across all core domains (science, clinical care, and practice),
- Promote elective diversity to support interdisciplinary specialization,
- And strengthen research engagement through expanded thesis requirements or modular options.

These steps will enhance the comparability, transparency, and mobility of pharmacy graduates across Europe, supporting the vision of a unified, internationally competent pharmaceutical workforce.