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Erasmus+KA220-HED,
Work Package 2 (WP 2): Harmonization of the Core Curriculum for Pharmacy Education and Enhancement of the Internationalization Process

Comparative Analysis Report

WP2 - Faculty of Pharmacy, University of Belgrade

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1. Introduction

A part of the Erasmus+ KA220-HED project, Work Package 2 (WP2) aims to provide insight into the differences, similarities, and areas for harmonization in pharmacy education that would enable enhanced internationalization and student mobility. Therefore, comparative analysis of pharmacy curricula at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) was performed. The structure, credit allocation and number of elective courses were the main focus of this comparative analysis. Finally, for students at the Faculty of Pharmacy, University of Belgrade exchange program proposal is prepared.

1.1. EU Regulations for the Regulated Profession of Pharmacist

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.

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.

In the Table 1 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	Belgrade	Athens	Poznan	Ljubljana	Zagreb	Hradec Králové
Minimum 5-year program	Yes	Yes	Yes	Yes	Yes	Yes
Minimum 6-month internship	Yes (9th and 10th semester)	Yes (9th and 10th semester)	Yes (11th semester)	Yes (9th and 10th semester)	Yes (10th semester)	Yes (9th and 10th semester)

1.2. Core Subjects in Pharmacy Curricula

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 patient care, healthcare systems, drug manufacture and marketing authorisation. 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, Pharmacokinetics, 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, Pharmaceutical Ethics and Pharmaceutical Legislation, Pharmaceutical Care & Patient Safety, Public Health & Pharmacoepidemiology,
- These subjects ensure that graduates are competent in patient 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 at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) to identify similarities, differences, and opportunities for internationalization and student mobility.

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).

This report presents a comparative analysis of the pharmacy curricula at these six institutions, focusing on course distribution, credit allocation, elective options, and areas for curriculum harmonization.

2. Methodology

The methodology for this comparative analysis was designed to provide a comprehensive and structured approach to examining the pharmacy curricula at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic). The goal was to identify similarities and differences that allow opportunities for enhanced internationalization and student mobility.

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.

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, 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.

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 course group/category.
- 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. industrial pharmacy, clinical pharmacy, biotechnology, regulatory affairs, alternative medicine).
- The ECTS weight of electives and how they contribute to degree completion.

2.2.4. 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.
- **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 curricula

The comparative analysis of pharmacy curricula at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) provides insights into the differences and similarities in pharmacy education that enable internationalization and student mobility. Each program follows the European Higher Education Area (EHEA) guidelines and ensures that students obtain an integrated five-year Master's degree (300 ECTS credits) in accordance with the EU Directive 2005/36/EC on the Recognition of Professional Qualifications. However, the structure, course content, number of electives and approaches to professional training vary from institution to institution. This section examines the main components of the curriculum, including core subjects, credit allocation, electives as opportunities for specialization.

3.1. General Curriculum Structure and ECTS Credit Distribution

All six universities follow the standards of the European Higher Education Area (EHEA) for integrated five-year pharmacy degree programs (300 ECTS), spread over five years of study (60 ECTS per year). The main difference for pharmacy study program at Poznan University of Medical Sciences (Poland) is its duration - 11 semesters and thus a total of 360 ECTS. For all study programs there are differences in the proportion of credits allocated to core subjects, electives and professional training (Table 2).

Table 2. Comparison of ECTS Credits distribution in Pharmacy program across the selected Universities

University	Total ECTS	Core Subjects ECTS	Elective Subjects ECTS	Diploma thesis ECTS	Professional training ECTS
Belgrade	300	244	22	16	18
Athens	300	230	18	12	40
Poznan	360	255	19	20	66
Ljubljana	300	215	25	30	30
Zagreb	300	248	12	10	30
Hradec Králové	300	213	15	31	41

Observations on ECTS Distribution

The distribution of ECTS is significantly influenced by the number of ECTS awarded for professional training, the final project and electives. In Poznan, 60 ECTS are awarded for professional training, which is located in the 11th semester and is therefore completely different from the other five study programs. In Athens, Hradec Králové, Zagreb and Ljubljana, the allocation of ECTS for professional training is quite balanced, while in Belgrade six months of practical training in a pharmacy are undervalued on the account of the accreditation request of 10% ECTS for electives. In Ljubljana and Hradec Králové the total count of ECTS for core subjects is lower than in the other four study programs, as the final project is awarded with over 30 ECTS.

3.2. Core Subjects Comparison

All institutions offer courses in Basic sciences, Pharmaceutical sciences, Biomedical and Clinical sciences, as well as 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 Sciences course structure in the reviewed pharmacy curricula

Course category	Belgrade			Athens			Poznan			Ljubljana			Zagreb			Hradec Králové		
	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS
CHEMISTRY	General and Inorganic Chemistry	1	6	Inorganic Chemistry I	1	5	General and Inorganic Chemistry	1*	10	General and Inorganic Chemistry	1	8	General Chemistry and Stoichiometry	1	9	General and Inorganic Chemistry	1	6
				Inorganic Chemistry II	2	5												
	Organic Chemistry 1	1	6	Organic Chemistry I	1	6	Organic Chemistry	1*	12	Organic Chemistry	3	9	Organic Chemistry	3	9	Organic Chemistry I	1	6
	Organic Chemistry 2	2	7	Organic Chemistry II	2	6										Organic Chemistry II	2	5
	Physical Chemistry	2	5	Physical Chemistry	4	5	Physical Chemistry	3& 4	5	Physical Chemistry	3	6	Physical Chemistry	2	9	Physical Chemistry	2	5
	Analytical Chemistry 1	2	4	Analytical Chemistry I	3	12	Analytical Chemistry	3& 4	9	Analytical Chemistry	2	8	Analytical Chemistry	2	9	Analytical Chemistry	3	3
	Analytical Chemistry 2	3	6	Analytical Chemistry II	4	8												
PHYSICS / BIOPHYSICS	Physics	1	3	General Physics	1	6	Biophysics	1*	2	Physics	1	8	Physics	1	5	Biophysics	1	4
BIOLOGY	Biology and Human Genetics	1	5	Biology	2	5	Biology with Basics of Genetics	1*	4	Pharmaceutical Biology with Genetics	1	7						
							Molecular Biology	4	2				Molecular Biology with Genetic Engineering	5	6	Molecular Biology and Genetics	4	4
													Cell Biology with Genetics	1	5.5	Cell Biology	1	4
MATHEMATICS &	Mathematics	1	4	General Mathematics	1	4	Mathematics with Elements of Statistics	1*	3	Mathematics	1	7	Mathematics	1	5	Mathematics	1	2

STATISTICS	Statistics in Pharmacy	5	3	Statistical Methods	2	5				Pharmaceutical Informatics	2	5	Biostatistics	2	3		
APPLIED ANALYTICAL SCIENCES	Instrumental Methods	3	6							Instrumental Pharmaceutical Analysis	5	4	Instrumental Techniques	3	5	Instrumental Methods	4	6
	Instrumental methods of biophotonics in pharmacy **(elective)**	6	4							Instrumental Analythical Methods in Pharmacy **(elective)**	6 / 8	5				Special Methods of Instrumental Analysis – lessons **(elective)**	5	2
										Selected Methods of Pharmaceutical Analysis **(elective)**	6 / 8	5				Special Methods of Instrumental Analysis – practical classes **(elective)**	5	4

*year

Key Insights from the Basic Sciences Course category

1. Chemistry sciences

General and/or Inorganic Chemistry is offered in the first semester at all the six universities, but only in Athens the subject is divided into Inorganic Chemistry I and Inorganic Chemistry II in the first and second semester. Depending on the faculty, the ECTS allocation is between 6 and 10 ECTS, with the highest credit allocation for this subject in Athens and Poznan and the lowest in Belgrade and Hradec Králové.

In Belgrade, Athens and Hradec Králové, Organic Chemistry is divided into two courses (parts 1 and 2) in the first and second semester, to which a total of 13, 12 and 11 ECTS are allocated, respectively. In Poznan, on the other hand, this subject is taught in one semester in the first year of study and awarded 12 ECTS, while in Zagreb and Ljubljana it is also introduced as a one-semester course, but only in the third semester and awarded 9 ECTS.

Physical Chemistry is offered at most faculties as a one-semester course in different semesters (2nd to 4th semester) with 5 or 6 ECTS, with the exception of Zagreb, which awards 9 ECTS for this course. The Faculty of Pharmacy at the Poznan University of Medical Sciences offers the subject as a full-year subject (3rd and 4th semester), but allocates 5 ECTS, similar to other faculties that offer it as a one-semester course.

In Belgrade, Athens and Poznan, Analytical Chemistry is provided as a full-year subject in the second and third or third and fourth semester, but with different credit points ranging from 9 ECTS in Poznan to 20 ECTS in Athens. In Ljubljana, Zagreb and Hradec Králové, it is offered as a one-semester course in the second or third semester and is assigned 8, 9 or 3 ECTS, respectively.

2. Physics and Biophysics

Physics or Biophysics is introduced in the first semester in all the study programs considered, but the number of ECTS allocated varies from 2 ECTS for Biophysics in Poznan to 8 ECTS for Physics in Ljubljana.

3. Biology

Biology-related courses are provided at all the six study programs starting early from the first semester, but the number and structure of these courses vary. In Belgrade, Poznan and Ljubljana, Biology with genetics is offered early on in the curricula and is credited with 4 to 7 ECTS. Athens offers Biology (2nd semester, 5 ECTS),. The Faculty of Pharmacy in Poznan offers Molecular Biology (4th semester, 2 ECTS). In Zagreb and Hradec Králové, Cell Biology (with Genetics) is provided in the first semester, followed by Molecular Biology with Genetic Engineering/Genetics in the 5th (6 ECTS) and 4th semester (4 ECTS), respectively.

4. Mathematics and Statistics

Mathematics is included in the curricula of all the six faculties in the first semester with different credit points, from 2 ECTS in Hradec Králové to 7 ECTS in Ljubljana. At the Faculty of Pharmacy in Hradec Králové there is no statistics subject in the curriculum, while in Poznan it is included in the Mathematics with Elements of Statistics (3 ECTS). While Athens and Zagreb offer Statistical Methods

and Biostatistics, respectively, in the second semester, Belgrade offers the Statistics in Pharmacy later, in the 5th semester. Interestingly, in Ljubljana, statistical methods are offered as part of the Pharmaceutical Informatics course in the 2nd semester.

5. Applied Analytical Sciences

Instrumental Methods in Pharmacy are included in the curricula of four faculties (Belgrade, Ljubljana, Zagreb and Hradec Králové) as core subjects in the 3rd, 4th or 5th semester and are also accompanied by the corresponding elective subjects. The number of credits allocated for the core subject are similar at the four faculties and range between 4 and 6 ECTS.

3.2.2. Pharmaceutical Sciences

The third, fourth and fifth year of pharmacy study programs generally focus on the pharmaceutical sciences, covering drug formulation, stability, manufacturing, biopharmacy, and quality control. These years are crucial in shaping student's ability to apply theoretical knowledge in the 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 Sciences course structure in the reviewed pharmacy curricula

Course category	Belgrade			Athens			Poznan			Ljubljana			Zagreb			Hradec Králové		
	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS
PHARMACEUTICAL CHEMISTRY /MEDICINAL CHEMISTRY	Pharmaceutical Chemistry 1	3	6	Medicinal Chemistry I	5	6	Pharmaceutical Chemistry	5 & 6	15	Pharmaceutical Chemistry I	2	6	Medicinal Chemistry and Drug Metabolism 1	4	6	Pharmaceutical Chemistry I	5	4
	Pharmaceutical chemistry 2	4	7	Medicinal Chemistry II	6	6				Pharmaceutical Chemistry II	4	7	Medicinal Chemistry and Drug Metabolism 2	5	6	Pharmaceutical Chemistry II	6	8
	Pharmaceutical Chemistry 3	5	9	Medicinal Chemistry III	7	6				Pharmaceutical Chemistry III	5 & 6	10 + 10	Medicinal Chemistry and Drug Metabolism 3	5	8.5			
				Medicinal Chemistry IV	8	6												
							Drug Design I	5	2									
							Drug Design II	6	2									
							Synthesis and Technology of Medicinal Products	5	6									
				Radiopharmaceutical Chemistry	4	4	Radiopharmaceutical Chemistry	3	1									
PHARMACEUTICAL TECHNOLOGY	Pharmaceutical Technology 1	6	9	Pharmaceutical Technology I	5	4	Dosage Form Technology I	5 & 6	12	Pharmaceutical Technology I	3 & 4	10 + 10	Pharmaceutics	4	5	Physical Principles of Dosage Forms	5	2
	Pharmaceutical Technology 2	7	7	Pharmaceutical Technology II	7	4	Dosage Form Technology II	5 & 6	9	Pharmaceutical Technology II	6	8	Drug Formulation 1	5	5	Pharmaceutical Technology I	6	5
	Pharmaceutical Technology 3	8	7	Pharmaceutical Technology III	8	4							Drug Formulation 2	6	4	Pharmaceutical Technology II	7	12
				Pharmaceutical	8	2							Magistral	7	3.5			

				Technology (Lab Works)									Pharmacy					
	Biological and Biosimilar Medicinal Products (elective)	8	4	Pharmaceutical Biotechnology (elective)	7	4	Pharmaceutical Biotechnology	3	2	Pharmaceutical Biotechnology	7	6				Biological Drugs	5	1
							Biotechnological Drug Technology	6	1	Selected Topics in Pharmaceutical Biotechnology (elective)	6/8	5	Biopharmaceuticals (elective)	8	2.5	Biotechnology (elective)	6	3
	Industrial Pharmacy	9	5				Industrial Pharmacy	5 & 6	3	Industrial Pharmacy (alternative)	8	5	Industrial Pharmacy	7	7	Industrial Production of Pharmaceutical Preparations (elective)	8	4
	Cosmetology	7	4	Cosmetics Technology-Cosmetology (elective)	6	3	Elements of cosmetology in pharmacy practice (elective)	7 & 8	5	Cosmetology (elective)	6/8	5	Dermatopharmacy and Cosmetology	8	5	Cosmetology for Pharmacists (elective)	7	2
							Natural cosmetics (elective)	9 & 10	2									
							Cosmeceuticals (elective)	5	2									
BIOPHARMACY & PHARMACOKINETICS	Pharmacokinetics with Pharmacogenomics	7	7	Biopharmaceutics Pharmacokinetics	5	5	Biopharmacy with Pharmacometrics	9	5	Biopharmaceutics with Pharmacokinetics	7	9	Biopharmaceutics and Pharmacokinetics	5	6	Pharmacokinetics (elective)	6	3
				Biopharmaceutics Pharmacokinetics (Lab Works)	6	2	Pharmacokinetics with Therapeutic Drug Monitoring	5	4	Biopharmaceutical Evaluation of Pharmaceutical Forms (elective)	6/8	5						
PHYTOTHERAPY & HERBAL DRUGS	Botany	4	7	General Botany	2	5	Pharmaceutical Botany with Elements of Biotechnology	1*	6				Pharmaceutical Botany	2	7.5	Pharmaceutical Botany I	1	3
				Pharmaceutical Botany (Theory	4	3										Pharmaceutical Botany II	2	5

				& Lab)														
	Pharmacognosy 1	5	4	Pharmacognosy I	5	6	Pharmacognosy	5 & 6	9	Pharmacognosy I	5	9	Pharmacognosy 1	4	7	Pharmacognosy I	4	3
	Pharmacognosy 2	6	6	Pharmacognosy I (Lab Works)	5	2				Pharmacognosy II	6	4	Pharmacognosy 2	5	6	Pharmacognosy II	5	7
				Pharmacognosy II	6	6												
				Pharmacognosy II (Lab Works)	6	2												
				Pharmacognosy III	8	6												
	Phytotherapy	7	4							Phytopharmaceuticals **(elective)**	6/8	5	Phytotherapy	9	2.5	Phytochemical Methods **(optional)**	5	2
																Phytopharmaceuticals **(elective)**	7	3
							Natural Products in Pharmacy	5 & 6	3									
PHARMACEUTICAL ANALYSIS	Drug Analysis	9	7	Pharmaceutical Analysis I	7	5				Analysis and Control of Medicinals	8	8	Pharmaceutical Analysis	6	10	Pharmaceutical Analysis I	4	4
	Sustainable Solutions for the development of Methods in Drug Control **(elective)**	9	4	Pharmaceutical Analysis II	8	5				Selected Methods of Pharmaceutical Analysis **(elective)**	6/8	5				Pharmaceutical Analysis II	5	7
				Pharmaceutical Analysis (Lab. Works)	8	2				Stability of Medicinals	7	5						
OTHER							Pharmaceutical Crime	7 & 8	1									
							Medical devices	9	4							Medical devices	7	2

*year

Key Insights from the Pharmaceutical Sciences Course Distribution

1. Pharmaceutical Chemistry/Medicinal chemistry

Pharmaceutical Chemistry/Medicinal chemistry is included in all the curricula reviewed, although the number of courses, the semesters in which the courses are delivered and the allocation of credits differ considerably. In Belgrade, there are three courses - Pharmaceutical Chemistry 1, 2 and 3, which take place in the 3rd to 5th semester and comprise a total of 22 ECTS, while in Ljubljana this subject is also divided into three parts, but is held in four semesters with a total of 33 ECTS. Poznan and Hradec Králové offer it in the 5th and 6th semesters, but as a full-year subject (15 ECTS) or as two separate subjects (12 ECTS), respectively. In Athens, there are four courses in Medicinal chemistry (I, II, III and IV) that are held from 5th to 8th semester and with total of 24 ECTS. Zagreb is offering the course in Medicinal chemistry with drug metabolism divided in three parts (20.5 ECTS in total), with part 1 that takes place in the 4th semester, while parts 2 and 3 are both located in the 5th semester. Poznan and Athens also offer Radiopharmaceutical Chemistry in the 3rd semester (1 ECTS) and 4th semester (4 ECTS), respectively. Additionally, Poznan offers courses in Drug design I and II (each 2 ECTS), as well as Synthesis and Technology of Medicinal Products (6 ECST) as compulsory courses in the 5th and 6th semesters. These topics are offered as elective courses in Belgrade and Ljubljana, while Zagreb and Hradec Králové do not have separate courses covering these themes.

2. Pharmaceutical Technology

Pharmaceutical Technology is widespread in the curricula at all six institutions and is divided into several courses that take place in different semesters from the 2nd to the 4th year of study. In Belgrade and Athens, the course is divided into three parts during the third and fourth year of study, but Athens additionally offers Pharmaceutical Technology (Lab Works), with a total of 28 ECTS for these four courses as opposed to 23 ECTS for three courses in Belgrade. Poznan, Ljubljana and Hradec Králové offer Pharmaceutical/Dosage Form Technology in two courses spanning two or three semesters. In Hradec Králové, the Pharmaceutical Technology I and II courses are preceded in the 5th semester by a course entitled Physical Principles of Dosage Forms, which aims to familiarize students with the basic physical principles involved in the formulation and stabilization of pharmaceutical dosage forms and the fundamentals of pharmaceutical nanotechnology ?. Of these three faculties, the Faculty of Pharmacy in Ljubljana awards the most credits (28 ECTS in total) through the courses that take place in the 3rd, 5th and 6th semesters. The Faculty of Pharmacy and Biochemistry in Zagreb awards four different courses in the field of pharmaceutical technology, which take place from the 4th to 7th semester, with a total of 17.5 ECTS.

Biotechnology topics are offered at all six faculties either as a compulsory subject (Poznan), as an elective subject (Belgrade, Athens, Zagreb) or both (Ljubljana, Hradec Králové). These courses are arranged differently in the reviewed curricula in terms of the semesters in which they are delivered and the number of ECTS attached. In Poznan, these subjects are introduced the earliest of all faculties, namely one compulsory subject in the 3rd semester, followed by a further compulsory subject in the 6th semester with a total of 3 ECTS, while in Ljubljana, for example, the compulsory subject related to biotechnology is introduced later, in the 7th semester (6 ECTS) and is followed by the elective subject in the 8th semester (5 ECTS).

Industrial Pharmacy is included in the curricula of all the faculties considered, with the exception of Athens, either as a compulsory subject (Belgrade, Poznan, Zagreb), an alternative subject (Ljubljana) or an elective subject (Hradec Králové). Courses are delivered in different semesters (5th to 9th semester) and a different number of ECTS (3 to 7) is awarded

Cosmetology courses are also included in most of the curricula reviewed. In Belgrade (7th semester, 4 ECTS) and Zagreb (8th semester, 5 ECTS) it is a compulsory subject, while in Athens, Ljubljana, Poznan and Hradec Králové it is possible to choose it as an elective subject, which is assigned with different number of ECTS, from 2 ECTS in Hradec Králové to 5 ECTS in Ljubljana.

3. Biopharmacy & Pharmacokinetics

In Athens, Ljubljana and Zagreb, educational contents related to biopharmacy and pharmacokinetics are offered in one core subject, although in Athens the theoretical and practical classes are divided into two courses that take place in different consecutive semesters. Ljubljana also offers an elective subject entitled *Biopharmaceutical evaluation of pharmaceutical forms*. In Poznan, there are two separate core subjects related to biopharmacy and pharmacokinetics. In Belgrade and Hradec Králové, only Pharmacokinetics is offered as a subject. In Belgrade, Pharmacokinetics with Pharmacogenomics is a compulsory subject, while the topics related to biopharmacy are included in the pharmaceutical technology subjects. In Hradec Králové, Pharmacokinetics is an elective subject, while biopharmacy is not offered as a separate course, which indicates that it can be included in the related courses similarly to Belgrade. The number of assigned ECTS for the core subjects of biopharmacy and pharmacokinetics vary from 6 to 9 ECTS, and the courses take place in different semester (5th to 9th semester).

4. Phytotherapy & Herbal Drugs

Botany is included in the curricula as a core subject or even divided into two core subjects (as in Athens and Hradec Králové), only at the Faculty of Pharmacy in Ljubljana this subject is not included in the curriculum. Botany is placed differently in the curricula, from the 1st semester in Hradec Králové to the 4th semester in Belgrade.

Pharmacognosy is included in all the reviewed curricula as a core subject spanning at least two semesters, either as a full-year course (e.g. in Poznan) or more often as two subjects, or even as three parts organized as five subjects with separate theoretical and practical courses (in Athens). Pharmacognosy-related courses start either in the 4th or 5th semester, while the assigned number of ECTS vary, with the lowest number of 9 ECTS in Poznan and the highest number of assigned credits in Athens, i.e. a total of 22 ECTS for five pharmacognosy courses.

Phytotherapy is a core subject in Belgrade (7th semester, 4 ECTS) and Zagreb (9th semester, 2.5 ECTS), while in Ljubljana and Hradec Králové Phytopharmaceuticals is included as an elective subject. The curriculum in Hradec Králové includes Phytochemical Methods as an elective subject, while Poznan offers a compulsory course Natural Products in Pharmacy (5th and 6th semester, 3 ECTS).

5. Pharmaceutical Analysis

All the reviewed curricula, except the one at the Faculty of Pharmacy in Poznan, have compulsory subjects related to drug analysis, although their position in the curricula varies, starting from the

earliest position in 4th and 5th semester in Hradec Králové to the latest in 9th semester in Belgrade. In Hradec Králové there are two courses Pharmaceutical Analysis I and II (4 + 7 ECTS), and in addition to these two courses in Athens (5 + 5 ECTS) there is a third course Pharmaceutical Analysis (Lab. Works) (2 ECTS). Related electives are also offered in Belgrade and Ljubljana. In Ljubljana Stability of medicines (8th semester, 5 ECTS) is offered as compulsory course while in Belgrade and Athens this topic is covered through other compulsory or elective course or within the elective courses oriented towards regulatory affairs.

6. Other

In Poznan, Pharmaceutical Crime (7th and 8th semester, 1 ECTS) and Medical devices (9th semester, 4 ECTS) are offered as compulsory courses. The other faculties are not offering topics related to pharmaceutical crime neither as separate elective course nor as a part of any compulsory or elective course. On the other hand, for medical devices in Hradec Králové is offered as a compulsory course in 7th semester (2 ECTS) while in Belgrade this course can be found as elective and in Athens only control and evaluation of topical medical devices is covered within elective course.

3.2.3. Biomedical and Clinical Sciences

3.2.3.1. Biomedical sciences

Biomedical science courses comprise an important and vital group of subjects in pharmacy studies since pharmacy represents regulated profession with great impact on human health and wellbeing. Named course category is essential for the comprehensive understanding of human body structure and properties. *Human anatomy, general biochemistry, genetics, physiology, food and nutrition*, and *immunology* are the foundation in understanding healthy human body processes and prospective understanding of processes and mechanisms in the disease (pathophysiology). The acquired knowledge enables understanding the impact of antigens on the human body functions (microbiology/parasitology) as well (Table 5). As mentioned, these subjects are the foundation for understanding the disease mechanisms, but at the same time are essential, in combination with pharmaceutical course category subjects, in understanding drug-drug interactions and side effects. The knowledge acquired through the *Biomedical sciences course category* can also be useful in disease prevention and pharmaceutical treatment protocols development.

The comparative analysis of the reviewed study programs is presented in Table 5, and indicates differences in subjects distribution per course category and the number of credits allocated (ECTS).

Table 5. Comparison of Biomedical Sciences course structure in the reviewed pharmacy curricula

Course category	Belgrade			Athens			Poznan			Ljubljana			Zagreb			Hradec Králové		
	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS
HUMAN ANATHOMY & PHYSIOLOGY	Physiology with the basics of anatomy and histology for pharmacists 1	1	3	Human anatomy	1	5	Human Anatomy	1 or 2	3	Anatomy and Histology	2	4	Physiology and Basic Anatomy	2	6			
	Physiology with the basics of anatomy and hystology for pharmacists 2	2	5	Physiology	3	5	Human Physiology	3	5	Physiology	3	6				Human Morphology and Physiology	3	8
	Physiology with the basics of anatomy and histology for pharmacists 3	3	5															
PATHOPHYSIOLOGY	Pathophysiology	4	7	Pathophysiology of diseases	4	5	Pathophysiology	4	6	Pathophysiology	5	6	Pathophysiology and Pathology	3	6	Pathological Physiology for Pharmacists	4	7
																Pathological Biochemistry	4	3
GENERAL BIOCHEMISTRY																		
	General Biochemistry	2	5	Biochemistry / Biochemistry (lab works)	3	6	Biochemistry	3	9	Pharmaceutical Biochemistry	4	7	Biochemistry	4	8	General Biochemistry	3	8
MICROBIOLOGY / PARASIT																		
	Microbiology	4	7	Pharmaceutical microbiology	4	5	Microbiology	4	6	Microbiology	2	4	Microbiology and Parasitology	3	7	Microbiology	2	4

OLOGY																		
IMMUNOLOGY	Immunology	3	5				Immunology	4	2				Immunology	6	4	Immunology	3	4
GENETICS	Biology and Human Genetics	1	5	There is only course BIOLOGY, the genetics is maybe the integrative part of this basic subject	2	5	Biology with Basics of Genetics	1 or 2	4	Pharmaceutical Biology with Genetics	1	7	Cell Biology with Genetics	1	5,5	Molecular Biology and Genetics	4	4
													Molecular Biology with Genetic Engineering	5	6			
FOOD AND NUTRITION	Bromatology	5	5	Food chemistry-nutrition	3	3	Bromatology	5	5				Physiological and Biochemical Aspects Of Nutrition	7	4			
	Dietetics	8	4										Micronutrition	9	2,5			

In red are highlighted subjects with incorporated topics on general biochemistry

Key Insights from the Biomedical Sciences category

1. Human Anatomy & Physiology

All the reviewed study programs provide subjects in the course category entitled *Human anatomy and Physiology*. The main difference encompasses the number of subjects within this course category, e.g. at the universities of Athens, Poznan and Ljubljana the human anatomy (*Human anatomy, Anatomy and Histology*) is studied separately from the human physiology (*Physiology)*. At other universities (Belgrade, Zagreb and Hradec Králové) these topics are integrated (*Physiology and Basic Anatomy, Human Morphology and Physiology, Physiology with the basic of anatomy and histology for pharmacists*). These topics are covered through one, two or three subjects situated from the 1st to 3rd semester as the acquired knowledge is the foundation for further studies of pathophysiology and disease mechanisms. The number of ECTS allocated to these subjects differs among Universities (from 3 to 8 ECTS), depending on the number of subjects in this course category which varies from one to three.

The difference of two or three ECTS points can be considered negligible, i.e. the subjects with ECTS points that differ slightly might be considered equivalent in the context of student mobility and the learning recognition. From the point of mapping subjects at different Universities in order to facilitate students' mobility, it is quite useful to note that equivalent subjects from the course category Human Anatomy & Physiology are thought in the same semesters (1st to 3rd).

2. Pathophysiology & Disease Mechanisms

All six Universities provide subject *Pathophysiology* in their curricula. The inclusion of this subject is supported by the fact that pathophysiology is linked to proper understanding of disease mechanisms and is essential for further understanding of pharmacology and pharmacotherapy, and the acquired knowledge is vital in understanding disease states and clinical decision-making. Across the reviewed curricula this subject is entitled similarly, *Pathophysiology* at the University of Belgrade, Poznan and Ljubljana, *Pathophysiology of diseases* at the University of Athens, *Pathophysiology and Pathology* at the University of Zagreb and *Pathological Physiology for Pharmacists* at the University of Hradec Králové. At the University of Hradec Králové additional subject, *Pathological Biochemistry*, is included in the curriculum (4th semester, with allocated 3 ECTS points). Without considering the additional subject at the University of Hradec Králové, it could be concluded that all the reviewed study programs include *Pathophysiology* course in similar semester, mostly in the 4th semester, 5th semester at University of Ljubljana and 3rd semester at University of Zagreb, and similar ECTS points are allocated for this subject (5-7 ECTS). From this standpoint, the *Pathophysiology* course could be a good choice to be included in the learning agreement for students' mobility among the selected Universities.

3. General Biochemistry

Biochemistry is recognized as one of the most important foundation subjects. General biochemistry is included in the curricula at the University of Belgrade and University of Hradec Králové as a standalone subject. This subject encompasses the general biochemical processes in human body and conveys very important teaching topics for understanding the pathology of diseases and drug actions. In the light of these facts, both *General Biochemistry* and *Biochemistry* are important part of

the pharmacy curricula. Regarding the reviewed study programs, *General Biochemistry* as standalone subjects is enclosed in the curricula at the University of Belgrade and at the University of Hradec Králové. At the University of Belgrade, *General Biochemistry* is positioned in the 2nd semester with allocated 5 ECTS points, followed by *Medical Biochemistry* as a separate subject with 7 ECTS in the 6th semester (this subject is considered as a clinical science, please se section 3.2.3.2). At the University of Hradec Králové, the *General Biochemistry* is positioned in the 3rd semester and 8 ECTS points are allocated to this subject.

At universities of Athens, Poznan and Zagreb *Biochemistry* is presented in the curricula and from the available subject content (University of Zagreb) it could be concluded that main teaching topics of *General Biochemistry* are included in the *Biochemistry* subject. *Biochemistry* is situated in the 3rd and 4th semester and 6 to 9 ECTS points are allocated to these subjects. The difference of 4 ECTS points is considered as significant. As well, it must be noted that at the University of Ljubljana subject *Pharmaceutical Biochemistry* can be found (4th semester, 7 ECTS).

4. Microbiology / Parasitology

Microbiology is subject neccessary for understanding microbial infections, their treatment and control, as well as the emerging issue of antimicrobial resistance. This subject is entitled slightly differently at different Universities, e.g. *Microbiology* at the Universities of Belgrade, Poznan, Ljubljana and Hradec Králové; *Pharmaceutical microbiology* at the University of Athens; *Microbiology and parasitology* at the University of Zagreb. Though in the subject title word *Parasitology* is not mainly present, these topics are integral part of the named subjects.

Microbiology is studied in the 4th semester at the universities in Belgrade, Athens and Poznan, in the 2nd semester at the University of Ljubljana and in Hradec Králové and in the 3rd semester at University of Zagreb. The allocated ECTS point range from 4 to 7

5. Immunology

Immunology is recognized as one of the necessery subjects for pharmacists. Although sometimes relevant topics are integrated in other subjects, such as *Microbiology*, *Immunology* as a separate subject is present at the University of Belgrade, Poznan, Zagreb and Hradec Králové. The subject is positioned in the 3rd or 4th semester, and the number of ECTS vary from 2 (Poznan University of Medical Sciences) to 5 (University of Belgrade).

6. Genetics

University of Belgrade includes the topics of genetics in the subject *Biology & Human Genetics* (5 ECTS), introducing genetics in the 1st semester. Similar situation is at the other universities reviewed, with certain differences in the subject titles (*Biology with basics of genetics, Pharmaceutical biology with genetics, Cell biology with genetics, Molecular biology and genetics*). The only exception is University of Athens, where subject *Biology* is defined in the curriculum, and genetics is probably the integral part of this subject but is not reflected in the title.

The allocated number of ECTS range from 4 to 7. The subject is realized in the 1st or 2nd semester in most Universities. Only at the University of Hradec Králové, the subject is conducted in the 4th semester.

7. Food and Nutrition

Food and Nutrition is an important subject in pharmacy education, including dietary principles, nutrition-related health issues, and the role of food in disease prevention and management. The gained knowledge and related skills will greatly contribute to pharmacists' role in prevention and management of non-communicable diseases and related public health promotion.

At the University of Belgrade (*Bromatology* and *Dietetics*) and at University of Zagreb (*Micronutrition* and *Physiological and biochemical aspects of nutrition*), represent two obligatory subjects related to Food and Nutrition that are included in the curricula. At the University of Athens subject related to the mentioned topics is entitled *Food chemistry – nutrition*, and at the Poznan University of Medical Sciences it is entitled *Bromatology*. At the universities in Ljubljana and in Hradec Králové, these subjects are offered as elective courses.

The situation is quite complex regarding position of the subjects from this course category within the curricula, since they are positioned starting from the 3rd to 6th semester. This is a challenge when organizing student mobility, including the fact that these subjects are not part of the Universities of Ljubljana and Hradec Králové curricula. The allocated ECTS points range from 3 to 5, and their distribution can be considered equivalent.

3.2.3.2. Clinical sciences

Clinical sciences course category involves subjects essential for education of pharmacists. Therefore, pharmacy students must acquire clinical sciences knowledge and skills in order to provide patients with adequate care, pharmacotherapy and make appropriate clinical decisions. In order to achieve all stated goals, students study subjects from the following groups: Pharmacology, Pharmacotherapy & Clinical pharmacy, Toxicology, Medical biochemistry (Clinical biochemistry) and *Pharmaceutical care*. *Pharmacology, Pharmacotherapy & clinical pharmacy and Medical biochemistry (Clinical biochemistry)*.

The comparative analysis for clinical sciences course category is presented in Table 6, and indicates the differences in subjects distribution and credits allocated (ECTS) to all defined subjects.

Table 6. Comparison of Clinical Sciences course structures in the reviewed pharmacy curricula

Course category	Belgrade			Athens			Poznan			Ljubljana			Zagreb			Hradec Králové		
	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS
PHARMACOLOGY	Pharmacology 1	5	7	Pharmacology I	5	6	Pharmacology with Pharmacodynamics	6	3	Pharmacology	7	5	Pharmacology 1	7	4	Pharmacology I	5	5
	Pharmacology 2	6	6	Pharmacology II	6	5	Pharmacology with Pharmacodynamics	7 & 8	10				Pharmacology 2	8	7	Pharmacology II	6	9
PHARMACOTHERAPY & CLINICAL PHARMACY	Pharmacotherapy	7	5				Hospital Pharmacy	8	2	Clinical Pharmacy (alternative course)	7	5	Clinical Pharmacy and Pharmacotherapy 1	7	3,5			
	Pharmacotherapy	8	4				Pharmacotherapy with Scientific Drug Information	7 & 8	6				Clinical Pharmacy and Pharmacotherapy 2	8	5			
	Clinical Pharmacy	9	7				Clinical Pharmacy	9 & 10	6							Clinical Pharmacy I	7	8
							Clinical Studies and Practical Specialized Pharmacotherapy	9 & 10	6									
TOXICOLOGY	Toxicology with analytics	8	8	Toxicology I	6	4	Toxicology	7 & 8	6	Toxicological Chemistry (alternative course)	7	5	Toxicology	8	5	Toxicology for Pharmacists	6	2
				Toxicology II	7	5												
CLINICAL BIOCHEMIST	Medical Biochemistry	6	7										Clinical Biochemistry with Haematology	6	3			

RY / MEDICAL BIOCHEMISTRY										Clinical Chemistry	8	7						
PHARMACEUTICAL CARE	/	/	/	Pharmaceutical care **(elective course)**	9	3							Pharmaceutical Care	9	6	Pharmaceutical Care I	7	6
																Pharmaceutical Care II	8	8

Key Insights from subjects distribution in Clinical sciences course category

1. Pharmacology

Pharmacology provides a strong foundation in drug action and therapeutic principles enabling the recquired knowledge and skills of a competent pharmacist.

Pharmacology 1 and *Pharmacology 2* are listed in the curricula at the universities in Belgrade, Athens, Zagreb and Hradec Králové. The named subjects are positioned in the 5th and 6th semester (Belgrade, Athens and Hradec Králové) or in the 7th and 8th semester (Zagreb). The allocated ECTS points are in range from 4 to 7 for *Pharmacology 1*, and from 5 to 9 for *Pharmacology 2*. Analyzing the position and ECTS points distribution, it could be concluded that slight differences exists for *Pharmacology 2* between the University of Athens and University of Hradec Králové where ECTS points discrepancy can be noted as significant. All other differences cannot be taken as a drawback from the students' mobility point of view.

Pharmacology with Pharmacodynamics (University of Poznan) is also subject in this course category and it is in the 6th, 7th & 8th semester. Number of allocated ECTS points is 3 (6th semester) and 10 (7th & 8th Similar situation is at the University of Ljubljana, where *Pharmacology* is thought in one semester (7th) and number of allocated ECTS points is 5.

2. Pharmacotherapy & Clinical Pharmacy

The situation in distribution of subjects and ECTS points in this course category is very diverse across the reviewed curricula. *Pharmacotherapy* is positioned in the 7th (ECTS 5) and 8th (ECTS 4) semester at the University of Belgrade. *Clinical Pharmacy and Pharmacotherapy I and II* are positioned in the 7th (ECTS 3.5) and 8th (ECTS 5) semester at the University of Zagreb. Though, the subjects have similar position and ECTS points distribution, University of Zagreb offers *Clinical Pharmacy and Pharmacotherapy* as an integrated obligatory subject while University of Belgrade listed both *Pharmacotherapy* and *Clinical pharmacy* (9th semester, ECTS 7) as standalone subjects. From the students' mobility point of view this is a notable difference.

Clinical pharmacy is a separate subject in the curricula at the University of Hradec Králové (7th semester, ECTS 8) and at the University of Ljubljana (7th semester, ECTS 5 – defined as alternative subject). Therefore, the *Clinical pharmacy* is situated in the 7th and 9th semester with 5 to 8 ECTS points allocated for this subject. Universities of Belgrade, Ljubljana and Hradec Králové can include *Clinical pharmacy* in a list of subjects for potential students' mobility plan.

The great difference is noticed at the University of Poznan. All subjects from this course category *Pharmacotherapy with Scientific Drug Information* (7th & 8th semester, ECTS 6), *Clinical Pharmacy* (9th & 10th semester, ECTS 6), *Clinical Studies and Practical Specialized Pharmacotherapy* (9th & 10th semester, ECTS 6) are two-semester subjects and are not convenient for student mobility program.

There are no separate subjects from this course category at the University of Athens.

3. Toxicology

There is a standalone subject *Toxicology* in all the reviewed curricula. At universities of Belgrade (*Toxicology with analytics*, 8th semester, ECTS 8), Ljubljana (*Toxicology – alternative course*, 7th

semester, ECTS 5), Zagreb (*Toxicology*, 8th semester, ECTS 5) and Hradec Králové (*Toxicology for pharmacists*, 6th semester, ECTS 2), *Toxicology* is taught as one semester subject. The distribution of these subjects through semesters and their allocated ECTS points are comparable, except for the University of Hradec Králové where only 2 ECTS points are allocated to *Toxicology for pharmacists.* This difference can be noted as a challenge for potential students mobility.

At the University of Athens the toxicology is thought as two one-semester exams (*Toxicology I* and *Toxicology II,* 6th semester, 4 ECTS, 7th semester, 5 ECTS) while at the University of Poznan, *Toxicology* is a two-semester subject (7th & 8th semesters) with allocated 6 ECTS points.

4. Clinical Biochemistry

At the University of Belgrade (*Medical Biochemistry*, semester 6th, 7 ECTS) and University of Zagreb (*Clinical Biochemistry with Haematology*, semester 6th, 3 ECTS) there are a standalone subjects related to *Clinical Biochemistry course category*. The discrepancy in ECTS points can be marked as significant.

At other universities only subjects entitled *Biochemistry* are listed in the curricula, and probably encompass both *General and Clinical Biochemistry* (teaching plans are not available from all selected universities to confirm this statement), which is explained in detail in section *3.2.3.1. Biomedical sciences, point 3 General Biochemistry*.

5. Pharmaceutical Care

Pharmaceutical care is a standalone subject at the University of Zagreb, where *Pharmaceutical Care I* (7th semester, 6 ECTS) and *Pharmaceutical Care II* (8th semester, 8 ECTS) are included in the curriculum. *Pharmaceutical Care* (9th semester, 3 ECTS) is also included in the curriculum at the University of Athens, but only as an elective subject.

There is a great discrepancy in ECTS points allocated to this course category, as well as the distribution of the subject throughout the semesters at the selected Universities.

3.2.4. Professional and Regulatory sciences courses

Professional and regulatory sciences course category is important part of pharmacists study program since these subjects prepare pharmacists for a real working surrounding by understanding law in a pharmacy field, patient care responsibilities, ethics, and business aspects of the pharmacy profession (Table 7). Therefore, this course category prepares students for medication dispensing, distribution and administration of medicines, patient management and concordance, collaborative and interprofessional practice, health systems including services for special patient population, health service organisation and economic evaluation in health etc.

The comparative analysis of the reviewed curricula is presented in Table 7, and indicates differences in subjects distribution and the number of credits allocated.

Table 7. Comparison of Professional and Regulatory Sciences course structures in the reviewed pharmacy curricula

Course category	Belgrade			Athens			Poznan			Ljubljana			Zagreb			Hradec Králové		
	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS	Course	S	ECTS
PHARMACEUTICAL ETICS & LEGISLATION	Pharmaceutical Ethics and Legislation	9	3	Pharmaceutical law and deontology	9	4	General Ethics	1	1				Basics in Pharmacy Business and Health Legislation	9	3	Laws and Ethics for Pharmacists	5	2
							Intellectual Property Protection	3	1									
							Professional Ethics	5	1									
							Pharmaceutical Law	5	1									
SOCIAL PHARMACY & PHARMACO-EPIDEMIOLOGY	Social pharmacy	8	6				Hygiene and Pharmacoepidemiology	1	3	Social Pharmacy	5	4	Social Pharmacy and Pharmacy Ethics	8	4	Social Pharmacy	7	5
							Pharmacoeconomics with Social Pharmacy	5	4				Consultation skills	9	1	Communication Skills for Pharmacists	7	2
PHARMACEUTICAL MANAGEMENT	Pharmaceutical marketing with pharmacoepidemiology (elective course)	8	4	Business administration marketing (elective course)	3	3				Pharmaceutical marketing and management (elective course)	68	5				Economics and Management of Pharmaceutical Practice	6	3
INTRODUCTION TO PHARMACY	Introduction to Pharmacy	2	1	History of pharmacy and introduction to ethnopharmacology	1	4	History of Pharmacy	1	1	Introduction to Pharmacy	2	3	Introduction to Pharmacy	1	0	History and Organization of Pharmacy	I	3

				and to pharmaceutical science														
PHARMACEUTICAL PRACTICE														Pharmacy Practice 1	2	1	Basics of Pharmacy Practice	1	2
														Pharmacy Practice 2	4	1	Propaedeutical Apothecary Practice	2	2
														Pharmacy Practice 3	6	3	Pharmacy Practice	9	2
														Pharmacy Practice 4	8	3			

Key Insights from Professional and Regulatory sciences course category

1. Pharmaceutical Ethics & Legislation

This course category is of great importance to raise awareness about the legal, professional, social and moral (ethical) responsibilities of pharmacists in the working framework. The pharmacy students acquire knowledge and skills regarding placing a medicine on the market, as well as the administrative and economic steps involved in the actions from drug development to its marketing, post-marketing follow-up and delivery to the patients phase.

Subjects from this course category are listed in the curricula of all reviewed study programs. These subjects are taught in the 9th semester at universities of Belgrade (*Pharmaceutical ethics and Legislation*, ECTS 3), Athens (*Pharmaceutical law and Deontology*, ECTS 4) and Zagreb (*Basics in Pharmacy Business and Health Legislation*, ECTS 3). It could be noticed that these subjects are comparable regarding the semester and ECTS points distribution at named universities, and can be taken into account for the students' mobility program. At the University of Hradec Králové the subject *Laws and Ethics for Pharmacists* is scheduled in the 5th semester and 2 ECTS points are allocated to this subject. The situation is the most complex at the University of Poznan, where different subjects from this course category are positioned throughout the curriculum. Therefore, *General Ethics* is positioned in the 1st semester (ECTS 1), *Intellectual property protection* is positioned in the 3rd semester (ECTS 1), while subjects *Professional Ethics* (ECTS 1), *Pharmaceutical Law* (ECTS 1) and *Methodology of Scientific research* (ECTS 10) are positioned in the 5th semester. Taking into account all presented data, it could be noticed that the University of Hradec Králové and Poznan are challenging for students exchange regarding this course category.

There is no subject from this course category at the University of Ljubljana.

2. Social Pharmacy & Pharmacoepidemiology

The subject Social Pharmacy is situated in the 8th semester at the University of Belgrade (*Social pharmacy*, ECTS 6) and at the University of Zagreb (*Social Pharmacy and Pharmacy Ethics*, ECTS 4). Further, at the University of Poznan (*Pharmacoeconomics with Social Pharmacy*, ECTS 4) and at the University of Ljubljana (*Social Pharmacy*, ECTS 4), named subject is situated in the 5th semester. The distribution of the ECTS points is also comparable. At the University of Hradec Králové, the *Social Pharmacy* is positioned in the 7th semester and 5 ECTS points are allocated for this subject. There is no similar subject at the University of Athens.

Subjects *Hygiene and Pharmacoepidemiology* (University of Poznan, 1st semester, ECTS 3), *Consultation skills* (University of Zagreb, 9th semester, ECTS 1) and *Communication Skills for Pharmacists* (University of Hradec Králové, 7th semester, ECTS 2) are additional subjects allocated to this course category.

3. Pharmaceutical management

The subject *Economics and management of Pharmaceutical practice* (6th semester, ECTS 3, University of Hradec Králové) is the only obligatory subject from this course category. Elective subjects related to this course category include*Pharmaceutical marketing and management* (6th and 8th semester – can be elected in both semesters, ECTS 5, University of Ljubljana), *Pharmaceutical marketing with*

pharmacoepidemiology (8th semester, ECTS 4, University of Belgrade), *Business administration and marketing* (3rd semester, ECTS 3, University of Athens) etc.

4. Introduction to pharmacy

The subjects related to this course category are: *Introduction to pharmacy* (2nd semester, ECTS 1, University of Belgrade), *History of pharmacy and Introduction to ethnopharmacology and to pharmaceutical science* (1st semester, ECTS 4, University of Athens), *History of pharmacy* (1st semester, ECTS 1, University of Poznan), *Introduction to pharmacy* (2nd semester, ECTS 3, University of Ljubljana), *Introduction to pharmacy* (1st semester, ECTS 0, University of Zagreb) and *History and organization of pharmacy* (1st semester, ECTS 3, University of Hradec Králové). The named subjects are delivered at the first year of pharmacy studies, and therefore are not very convenient for students' exchange.

5. Pharmaceutical Practice & Patient-Centered Services

Pharmacy practice course category contains subjects at the Universities of Hradec Králové and Zagreb. *Pharmacy practice 1* (2nd semester, ECTS 1), *Pharmacy practice 2* (4th semester, ECTS 1), *Pharmacy practice 3* (6th semester, ECTS 3), *Pharmacy practice 4* (8th semester, ECTS 3) are part of the University of Zagreb curriculum, while *Basics of pharmacy practice* (1st semester, ECTS 2), *Propaedeutical apothecary practice* (2nd semester, ECTS 2) and *Pharmacy practice* (9th semester, ECTS 2) are part of the University of Hradec Králové curriculum. The named subjects are listed only at two selected Universities and therefore not of great interest in students mobility plan.

3.2.5. Distribution of ECTS credits across the main course categories

Pharmacy education in Europe varies greatly depending on the national priorities, educational philosophy and professional expectations. A look at the curricula of the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) shows how each institution structures its program to strike a balance between theoretical knowledge, practical skills and clinical application.

Figure 1. visually compares the ECTS credit distribution across key subject categories in the pharmacy programs at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic). It highlights the different emphasis that each institution places on the Basic sciences, Pharmaceutical sciences, Biomedical sciences, Clinical sciences and Professional & Regulatory sciences, and emphasizes the differences in curriculum structure and focus.

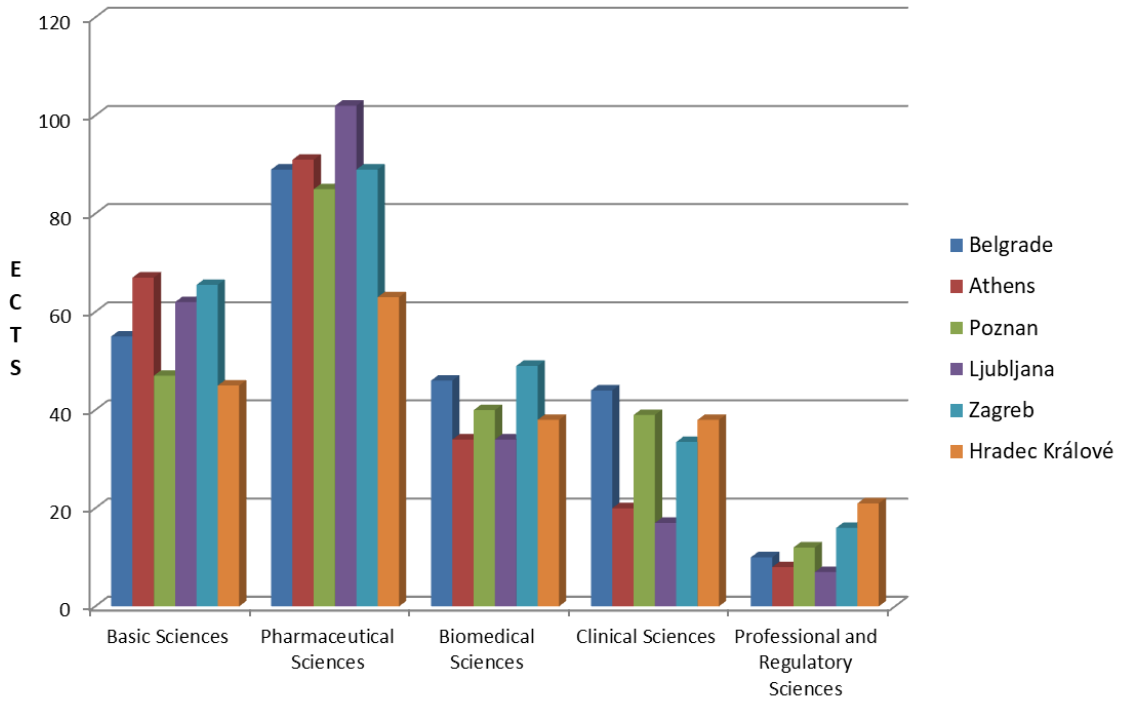

Figure 1. ECTS distribution across core subject categories in the pharmacy programs at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic)

The number of ECTS allocated to the Basic Sciences course category ranges from 47 (in Poznan) to 67 (in Athens) with the average number of 57 ECTS. In the case of Pharmaceutical Sciences, the number of ECTS allocated ranges from 63 (in Hradec Králové) to 102 (in Ljubljana) with the average number of around 87 ECTS. The number of ECTS allocated to the Biomedical Sciences ranges from 34 (in Athens and Ljubljana) to 49 (in Zagreb), with the average number of around 40 ECTS. In the Clinical Sciences course category, the number of ECTS ranges from 17 (in Ljubljana, where Clinical pharmacy is offered as an "alternative" subject and, thus, excluded from this score) to 44 (in Belgrade) with the average of 32 ECTS. It can be noticed that the number of ECTS allocated to the course categories Biomedical and Clinical Sciences is highest at the University of Belgrade (total of 90 ECTS), followed by the University of Zagreb (total of 82.5 ECTS). The number of ECTS allocated to the Professional and Regulatory Sciences course category ranges from 7 (in Ljubljana) to 21 (in Hradec Králové) with the average number of around 12 ECTS.

It should be taken into account that the total number of ECTS allocated to core curricula also varies among the reviewed study programs depending on the number of ECTS allocated to elective subjects, diploma thesis and students professional placements/professional training.

3.3. Elective Courses

Elective courses play an important role in pharmacy education. They allow students to customize their learning experiences based on their personal interests, career aspirations, and the evolving needs of the professional responsibilities of pharmacists. Electives also provide opportunities for specialization in the areas of pharmacy.

While the compulsory courses provide a uniform foundation, the electives offer unique academic strengths and opportunities for specialization, which is why institutions differ from one another in this segment of study programs. This section provides a comparative analysis of the elective courses offered at each of the reviewed study programs focusing on the overall distribution of ECTS, subject diversity and opportunities for interdisciplinary learning.

3.3.1. Comparison of Elective Courses

Table 8. Comparative analysis of the elective courses structure and distribution in the reviewed pharmacy curricula

University	Elective Subjects total ECTS	Number of elective /alternative / optional courses in the study plan (1)	Number of offered elective courses (2)	Ratio (2)/(1)	Semesters offering elective courses
Belgrade	22	6	63	10.5	1st, 2nd, 4th, 6th, 8th and 9th
Athens	18	6	21	3.5	3rd, 4th, 5th, 6th, 7th, 8th and 9th
Poznan	19	5	97	19.4	1st or 2nd, 3rd or 4th, 5th or 6th, 7th or 8th and 9th or 10th
Ljubljana	25	alternative 2 elective 3	4 22	2 7.33	7th and 8th 6th and 8th
Zagreb	12	Students can choose from over 30 elective courses available from the second to fifth year, allowing them to tailor their education to their specific interests and explore a wide range of topics			
Hradec Králové	15	optional 6 elective 4	26 24	4.33 6	1st- 7th 5th - 8th

Poznan has the highest number of electives (97) and the highest choice ration (19.4 electives per required elective). In addition, the electives are spread over all semesters. Quite simmilar situation is in Belgrade with 63 elective courses (the choice ratio is 10.5) and the electives are spread over six semesters.

Ljubljana and Hradec Králové offer a completely different approach with a combination of alternative/optional courses and electives. In Ljubljana, there is an obvious intention to support certain specialization interest of students with alternative courses in the 7th and 8th semesters. On the other hand, optional courses in Hradec Králové in the first four semesters focus mainly on additional skills such as professional language or physical education and sports, while in the 6th and 8th semesters optional courses are more focused on acquiring certain specific knowledge like homoeopathic preparations or applied bioinformatics.

In Athens the system is rather flexible despite the lowest choice ratio. Namely, study program includes 21 elective courses from which student must select courses to earn a total of 18 ECTS.

3.3.2. Diversity of Elective Courses Topics

The range of elective courses available significantly impacts students' ability to specialize in pharmaceutical fields. Below is a comparison of elective course themes across the six universities (Table 9).

Table 9. Comparison of elective course themes in the reviewed pharmacy curricula

Course category	Belgrade	Athens	Poznan	Ljubljana	Hradec Králové
FUNDAMENTAL & APPLIED SCIENCES	Application of information methods in pharmacy, Introduction to laboratory work, Safe handling of chemicals and waste in pharmacy, Mechanisms of organic reactions in biological processes, Artificial intelligence and applications in pharmacy, Fundamentals of medical genetics, Colloid Chemistry, Bioelements, Fundamentals of Genomics, Analysis of Real Samples with the Green Chemistry Module Biodiversity and Pharmacy, Instrumental methods of biophotonics in pharmacy,	Introduction to Programming and Computational Applications, Pharmaceutical Botany, Special Courses in Organic Chemistry,	Physical fitness and posture development, Issues of social pathology,Sociology of health and medicine, Student–Graduate–Employee, Health behaviors of Polish society, Chemistry in everyday life, Propaedeutics of biophysics, Social communication, Chemical substance nomenclature systems, Intermolecular interactions, Basics of biocrystallography, Advances in heterocyclic chemistry, Structure and role of selected biomolecules, Microwave techniques in pharmaceutical sciences, Use of electromagnetic radiation in organic compound analysis, Foreign language in pharmaceutical practice, Foreign language classes (English, French, German), Basics of neurobiology,		Exercises in General Chemistry, English Language for Pharmacists, Professional Language Preparation I, Physical Training and Sports I, Applied Computer Technology, Constitution of Organic Compounds, Exercises in Organic Chemistry, Selected Chapters from History of Pharmacy, English Language for Pharmacists, Professional Language Preparation I, Physical Training and Sports I, Summer Sports Course, Physical Training and Sports III, Winter Sports Course, Introduction to Applied Bioinformatics, Physical Training and Sports III, Advanced Organic Chemistry,
PHARMACEUTICAL & BIOMEDICAL SCIENCES	First aid, Selected chapters of physiology, Biochemistry of special physiological conditions and diseases, Applied immunology: prophylaxis, diagnostics and therapy of diseases, Modern approaches in research and clinical application of RNA, Applied pathophysiology in modern pharmaceutical practice, Interpretation of basic biochemical and hematological parameters, Target sites of action of biological drugs in immune-mediated diseases, Drug chemistry in modern therapy of malignant, endocrine and rare diseases		Innovative molecular biology methods in diagnostics,	Pharmacogenomics and Genetic Medicines, Immunology, The Use of Genetic and Cellular Testing in Biomedicine and Pharmacy,	Immunopharmacology, Pharmacokinetics, Gene Therapy,

CLINICAL & PUBLIC HEALTH & PHARMACY	Professional development of pharmacists, Communication in Pharmaceutical Practice, Public health in pharmaceutical practice, Sports pharmacy, Communication in pharmaceutical practice, Natural products in complementary treatment methods/Basics of homeopathy, Contrast agents and radiopharmaceuticals, Rational self-medication, Addictive substances, Biochemical aspects of reproductive health, Clinical pharmacokinetics, Acute drug poisonings, Chemical carcinogens, Ecotoxicology, sustainable development and planetary health,	Epidemiology, Clinical Chemistry, Pharmaceutical Care, Drug Metabolism, Molecular Pharmacology, Introduction to Clinical Pharmacy	Kinesiology, Family planning and sexology, Development of sexology with focus on biological and medical aspects, Physical activity as prevention of occupational diseases, Molecular mechanisms of absorption/excretion disorders – kidney and intestine, Selecting drug synonyms using "KS Apteka" software, Digital imaging in medicine and pharmacy, Cost assessment of OTC drug therapy, Gene therapy as a pharmacotherapy alternative, Drug safety monitoring (pharmacovigilance), Biological basis of civilization diseases, Clinical pharmacokinetics – calculations, Computerization in medicine – databases and management systems, Communication in pharmacy, Microbiological hygiene control in health institutions, Geriatric pharmaceutical care, Professional advice in pharmacy, Knowledge-based entrepreneurship, Diagnostic testing in public pharmacies, Wellness – building psychophysical balance, Pharmacist-doctor cooperation in the health care system, Pharmaceutical counseling in skincare and homeopathy, Pharmacist's role in maternal and child health, Health problems in adulthood and old age, Is it easier being a man or a woman? Andropause & Menopause, Monitoring adverse reactions according to EU regulations, Oncology patient care, Practical aspects of pharmaceutical care implementation, Self-medication – mistakes and life-threatening risks, Doctor-pharmacist cooperation in the healthcare system	Toxicological Chemistry, Clinical Pharmacy, Biochemistry of Cancer Development and Progression, Hospital Pharmacy, Selected Topics in Clinical Biochemistry, Psychotropic substances and Abuse of Medicinal Products, Medicinal Products of Alternative Medicine, Research Methods in Social Pharmacy	Xenobiochemistry, Xenobiochemistry - Practical Training, Extemporaneous Preparation in Hospital Pharmacy, Clinical - Pharmaceutical Care

PHARMACEUTICAL TECHNOLOGY & DRUG DEVELOPMENT	How to bring medicinal product to market, Chemical Stability of Active Pharmaceutical Ingredients, Metabolism in drug development and application, Drug design and synthesis, Drugs with multiple actions - innovative approaches in medicinal chemistry, Toxicity testing in drug development	Basic Principles of Drug Design, Dosage Form Design, Properties and Applications of Raw Materials, Stability of Pharmaceutical Products,	Biomaterials and nanotechnology for pharmacists, Basics of cheminformatics, Modern wound dressings, Introduction to molecular modeling, Clinical trials, Advanced biostatistics, Clinical pharmacokinetics – calculations, Basics of scientific information,	Design and Synthesis of Active Substances, Eutomers,	Current Trends in the Development of Chemical Drugs, Basics of Molecular Modelling of Drugs, Development of Pharmaceutical Products, Selected Methods of Pharmaceutical Technology, Development of Pharmaceutical Products
HERBAL & NUTRITIONAL SCIENCES	Quality of herbal drugs and preparations, Circular economy in pharmacy, Principles of sustainable nutrition, Nutraceuticals in pharmacy,	Food Chemistry - Nutrition, Special Courses in Pharmacognosy	Aromatherapy, Active natural substances in beer, Medicinal and protected plants in natural and cultivated conditions, Herbal recipes for everyday use, Nature's pharmacy – Medicinal Plant Garden, Chromatographic methods in plant drug analysis, Isolation and analysis of bioactive compounds from plants, Medicinal, cosmetic, and industrial plants, Plant and animal raw materials in homeopathyMedicinal, cosmetic, and industrial plants, Fungi and lichens – their importance, Nutrition principles in different age groups, Interactions of herbal raw materials with medicines and supplements, Herbal ingredients in cosmetics and spices,	Phytopharmaceuticals, Nutritional Supplements,	Phytochemical Methods, Medicinal Plants Production, Technology of Natural Drugs, Phytopharmaceuticals,
COSMETICS & APPLIED PHARMACY		Cosmetic Technology - Cosmetology, Control And Evaluation of Cosmetic and Topical Medical Devices,	Bee products – action and use in therapy, Cosmeceuticals, Nutricosmetics, Elements of cosmetology in pharmacy practice, Photoprotectors and photosensitizers, Modern environmental threats, Chemical analysis of nutricosmetics and cosmeceuticals, Physical activity for health promotion, Natural cosmetics,	Cosmetology	Cosmetology for Pharmacists

BIOTECHNOLOGY & PHARMACOTHERAPY & INDUSTRY	Industrial Microbiology, Pharmaceutical marketing with pharmacoepidemiology, Medical devices, Veterinary medicines, Biological and biosimilar medicinal products, Novel drug delivery systems, Clinical research and pharmacovigilance, Dosage forms for paediatric population, Pharmacotherapy in pediatrics, Pharmaceutical regulation in drug control, Quality of pharmaceutical packaging materials and packaging, Sustainable solutions for the development of methods in drug control, Pharmaceutical supply chain with pharmacoeconomics, Interprofessional education, Toxicological risk assessment in pharmacy, Pharmacotherapy in oncology	Biopharmaceutics - Pharmacokinetics II, Business Administration-Marketing, Pharmaceutical Biotechnology, Novel Drug Delivery Systems,	ABC of veterinary pharmacy, Microbiological control of pharmaceutical and cosmetic products, PPG pharmacology (perinatal, pediatric, geriatric), Sex hormones – rational use of hormonal preparations, Blood-derived preparations, Selected aspects of structural X-ray diffraction, Plant biotechnology in pharmacy, Intellectual property in pharmaceutical market, GMP rules in drug manufacturing and distribution, Analysis of compound drugs, Geriatric pharmacotherapy – case studies, Pharmacy marketing, Drug and pharmaceutical product stability, Managerial techniques, Medical and pharmaceutical devices in the context of EU directives	Industrial Pharmacy, Biopharmaceutical Evaluation of Pharmaceutical Forms, Modified Release Pharmaceutical Forms, Pharmaceutical Engineering, Pharmaceutical Marketing and Management, Pharmacoeconomics, Selected Topics in Pharmaceutical Biotechnology, Selected Methods of Pharmaceutical Analysis, Quality of Medicinal Products, Instrumental Analythical Methods in Pharmacy,	Technology of Homoeopathic Preparations, Special Methods of Instrumental Analysis, Advanced Separation Methods, Biotechnology, Technology of Synthetic Drugs, Radiopharmacy, Industrial Production of Pharmaceutical Preparations I, Industrial Production of Pharmaceutical Preparations II,

Belgrade offers the widest range of electives, covering the fields of research and drug development, regulatory affairs, clinical pharmacy, specialized pharmaceutical sciences, biotechnology and pharmaceutical industry. In Poznan a large number of elective courses can be found in the field of herbal and nutritional sciences, as well as clinical pharmacy and public health. Due to a large number of optional courses in the first four semesters, which mainly focus on additional skills such as applied computer technology or summer/winter sports courses, basic skills predominate in Hradec Králové. However, electives in drug development, biotechnology and pharmaceutical industry are also abundant. Electives in Ljubljana focus mainly on biotechnology and pharmaceutical industry as well as clinical sciences and pharmacy. In Athens, the electives also focus on cosmetology, while research and development, clinical pharmacy and public health, biotechnology and pharmaceutical industry are balanced in the offer.

3.3.3. Timing and Flexibility of Electives

Table 10. Comparison of Elective courses timing, selection process and flexibility in the reviewed pharmacy curricula

University	Semesters offering elective courses	Elective course selection process	Flexibility level
Belgrade	1st, 2nd, 4th, 6th, 8th and 9th	Students select one course from a fixed set of 6 groups	High (large variety and spread over multiple semesters)
Athens	3rd, 4th, 5th, 6th, 7th, 8th and 9th	Students select 6 courses from a list of 21 course	High (spread over multiple semesters and students are allowed to flexibly select courses to earn 18 ECTS)
Poznan	1st or 2nd, 3rd or 4th, 5th or 6th, 7th or 8th and 9th or 10th	Students select one course from a fixed set of 5 groups	High (largest variety and spread over all semesters)
Ljubljana	7th and 8th 6th and 8th	Student select one alternative course from a fixed set of 2 groups with two courses in each group Student select 3 courses from a list of 22 courses (one in 6th and two in 8th semester)	High (a combination of alternative and electives courses; students are allowed to flexibly select elective courses to earn 15 ECTS)
Zagreb	Students can choose from over 30 elective courses available from the second to fifth year, allowing them to tailor their education to their specific interests and explore a wide range of topics		
Hradec Králové	1st- 7th 5th - 8th	Students are allowed to select optional/elective courses from the list with the recommendation of the study year for optional courses and area of specialization for elective courses	High (a combination of optional and electives courses and spread over multiple semesters)

In Poznan, Belgrade and Hradec Králové, electives are offered in several semesters so that students can gradually acquire expertise in specific areas or choose different topics and diversify acquired knowledge. In Athens, the electives are spread over several semesters and students are allowed to flexibly select courses in order to acquire a predetermined number of ECTS. Similarly, in Zagreb, students can tailor their education to their specific interests and explore a wide range of topics choosing from a set of elective courses available from the second to fifth year. In Ljubljana quite high flexibility is offered from the 6th to the 8th semester and students have the possibility to choose electives to acquire a predefined number of ECTS according to their preferences.

3.4. Internationalization and Student Mobility

In an increasingly globalized pharmaceutical sector, internationalization and student mobility play an important role in ensuring that pharmacy graduates are equipped for international careers. This report examines the internationalization efforts of University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) focusing on English-language study programs and student exchange opportunities through Erasmus+ and bilateral agreements.

1. Availability of Study Programs in English-

University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) offer pharmacy degree programs in English, which makes them suitable for international students and exchange participants. By offering degree programs in English, these faculties provide their students with greater international exposure and a competitive advantage in global pharmaceutical practice.

2. Student Exchange Programs: Strengthening International Collaboration

Student mobility programs, especially within the framework of the Erasmus+ program and bilateral agreements, offer students the opportunity to study abroad, gain intercultural experience and expand professional networks. These programs promote knowledge exchange, adaptation to different healthcare systems and global career readiness.

University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) actively participate in the Erasmus+ program and have extensive bilateral agreements that enable students to study at partner universities across Europe and beyond. Their strong commitment to international programs facilitates mobility for both incoming and outgoing students.

Increased collaboration with international pharmaceutical companies and research institutions could also provide expanded internship and research opportunities abroad.

4. Exchange program proposal for students at the Faculty of Pharmacy, University of Belgrade

A student at the University of Belgrade can apply for any kind of mobility after nomination by his/her home faculty. The prerequisite is that the study program at the home faculty is compatible with the study program of the receiving institution in which the student is interested and that the student can present a sufficient number of ECTSs per semester or academic year that could be recognized upon his/her return to the University of Belgrade. The entire procedure should be supervised by the responsible ECTS coordinator at the respective faculty of the University of Belgrade. The

recommended minimum number of ECTS credits per semester is 19[1]. It is required that the student lists the selected courses at the receiving institution in the relevant Learning Agreement, which is signed by the student, the responsible person, i.e. the ECTS coordinator at the student's home faculty, and the responsible person at the receiving institution.

Therefore, we have tried to identify the opportunities and prepare a proposal for a student exchange program between the Faculty of Pharmacy (FP) University of Belgrade (home institution) and FPs at National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) as receiving institutions. The proposal focuses on the mobility for one semester, taking into account the recommended minimum number of ECTS per semester. Since the entire procedure requires about a year for administrative and other activities, the mobility "packages" did not include the first four semesters. The proposal can facilitate the preparation of Learning agreements for students and approval by the ECTS coordinators in the home and receiving institutions. The proposed mobility "packages" are listed in Tables 11 - 15.

As a general challenge previously discussed in sections 3. Comparative analysis of Pharmacy study programs, all of the programs analyzed have the required core subjects, but they are arranged differently in each semester. For this reason, it was quite difficult to put together the mobility "packages" that fulfill the requirement of at least 19 ECTS. The second challenge was the difference in the number of ECTS allocated to each selected course. Even if we take into account the acceptable differences in ECTS, there are situations where more than 4 ECTS can be identified as differences between courses. These differences should be further discussed and appropriately resolved by the ECTS coordinators of the home and receiving institutions. In addition, the outcomes and course content are not available on the websites of all faculties, so the proposed mobility "packages" should be further assessed with those responsible at the potential partner institutions.

[1] https://www.bg.ac.rs/mobilnost-i-razmena/

Table 11. Proposal for students' exchange program between the FP University of Belgrade and FP in Hradec Králové, Charles University

Home Institution FP University of Belgrade				**Host Institution FP in Hradec Králové, Charles University**			
Student Exchange Program during the 6th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
VI	Pharmacology 2	C	6	**VI**	Pharmacology II	C	9
VI	Pharmaceutical Technology 1	C	**9**	**VI**	Pharmaceutical Technology I	C	**5**
VI	Pharmacognosy 2	C	6	**V**	Pharmacognosy II	C	7
VI	Medical Biochemistry	C	**7**	**IV**	Pathological Biochemistry	C	**3**
VI	Applied immunology: prophylaxis, diagnostics and therapy of diseases	E	4	**VI**	Immunopharmacology	E	3
		Total ECTS	**32**				
Student Exchange Program during the 7th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
VII	Pharmaceutical Technology 2	C	**7**	VII	Pharmaceutical Technology II	C	**12**
VII	Phytotherapy	C	4	VII	Phytopharmaceuticals	E	3
VII	Cosmetology	C	4	VII	Cosmetology for Pharmacists	E	2
VIII	Social pharmacy	C	6	VII	Social Pharmacy	C	5
		Total ECTS	**21**				

In red are highlighted the semesters of the subjects that are not in the same semester in the curricula of home and receiving institution.

In blue are highlighted the ECTS of the subjects that are not in agreement at home and receiving institution.

Table 12. Proposal for students' exchange program between the FP University of Belgrade and FP University of Ljubljana

Home Institution FP University of Belgrade				**Host Institution FP University of Ljubljana**			
Student Exchange Program during the 7th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
VII	Pharmacokinetics with pharmacogenomics	C	7	**VII**	Biopharmaceutics with Pharmacokinetics	C	9
VIII	Toxicology with analytics	C	8	**VII**	Toxicological Chemistry	A	5
VIII	Drug design and synthesis	E	4	**VI**	Design and Synthesis of Active Substances	A	5
		Total ECTS	**19**				
Student Exchange Program during the 9th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
IX	Clinical Pharmacy	C	7	**VIII**	Clinical Pharmacy	A	5
IX	Industrial Pharmacy	C	5	**VIII**	Industrial Pharmacy	A	5
IX	Drug Analysis	C	7	**VIII**	Analysis and Control of Medicinals	C	8
IX	Nutraceuticals in pharmacy **or** Pharmaceutical supply chain with pharmacoeconomics	E	4	**VIII**	Nutritional Supplements	E	5
				VIII	Pharmacoeconomics	E	5
		Total ECTS	**23**				

In red are highlighted the semesters of the subjects that are not in the same semester in the curricula of home and receiving institution.

Table 13. Proposal for students' exchange program between the FP University of Belgrade and FP National and Kapodistrian University of Athens

Home Institution FP University of Belgrade				**Host Insitution FP Natioanal and Kapodistrian University of Athens**			
Student Exchange Program during the 5th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
V	Pharmacology 1	C	7	V	Pharmacology I	C	6
V	Pharmacognosy 1	C	4	IV	Pharmacognosy I	C	6
				IV	Pharmacognosy I (lab works)	C	2
V	Statistics in Pharmacy	C	3	II	Statistical methods	C	5
V	Bromatology	C	5	VII	Food Chemistry - Nutrition	E	3
		Total ECTS	**19**				
Student Exchange Program during the 9th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
IX	Clinical Pharmacy	C	**7**	**VIII**	Introduction to Clinical Pharmacy	E	**3**
				IX	Pharmaceutical Care	E	3
IX	Pharmaceutical Ethics and Legislation	C	3	**IX**	Pharmaceutical law and deontology	C	4
IX	Drug Analysis and Pharmaceutical regulation in drug control	C + E	7 + 4	**VII**	Pharmaceutical analysis I	C	4
				VIII	Pharmaceutical analysis II	C	5
				VIII	Pharmaceutical analysis (lab works)	C	4
		Total ECTS	**21**				

In red are highlighted the semesters of the subjects that are not in the same semester in the curricula of home and receiving institution.

In blue are highlighted the ECTS of the subjects that are not in agreement at home and receiving institution.

Table 14. Proposal for students' exchange program between the FP University of Belgrade and FP Poznan University of Medical Sciences

Home Institution FP University of Belgrade				**Host Insitution FP University of Poznan**			
Student Exchange Program during the 4th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
III	Immunology	C	5	**IV**	Immunology	C	2
IV	Microbiology	C	7	**IV**	Microbiology	C	6
IV	Pathophysiology	C	7	**IV**	Pathophysiology	C	6
		Total ECTS	**19**				
Student Exchange Program during the 9th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
VIII	Social pharmacy	C	6	IX	Pharmaceutical economics with social pharmacy	C	4
IX	Clinical pharmacy	C	7	IX	Clinical pharmacy	C	6
IX	Pharmaceutical ethics and Legislation	C	3	IX	Professional ethics	C	1
VIII	Medical devices	E	4	IX	Medical devices	C	4
		Total ECTS	**20**				

In red are highlighted the semesters of the subjects that are not in the same semester in the curricula of home and receiving institution.

Table 15. Proposal for students' exchange program between the FP University of Belgrade and FP University of Zagreb

Home Institution FP University of Belgrade				Host Institution FP University of Zagreb			
Student Exchange Program during the 4th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
III	Instrumental methods	C	6	**III**	Instrumental techniques	C	5
IV	Pathophysiology	C	7	**III**	Pathophysiology and Pathology	C	6
IV	Microbiology	C	7	**III**	Microbiology and Parasitology	C	7
		Total ECTS	**20**				
Student Exchange Program during the 9th semester							
Semester	**Subject**	**Type**	**ECTS**	**Semester**	**Subject**	**Type**	**ECTS**
VIII	Toxicology with analytics	C	8	**VIII**	Toxicology	C	5
VIII	Social pharmacy	C	6	**VIII**	Social pharmacy and Pharmacy Ethics	C	4
IX	Drug analysis	C	7	**VI**	Pharmaceutical analysis	C	10
IX	Industrial pharmacy	C	5	**VII**	Industrial pharmacy	C	7
		Total ECTS	**26**				

In red are highlighted the semesters of the subjects that are not in the same semester in the curricula of home and receiving institution.

5. Conclusions and Recommendations

This comparative analysis of the pharmacy curricula at the University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic) reveals both similarities and structural differences in pharmacy curricula at the various institutions. Although all six universities adhere to the standards of the European Higher Education Area (EHEA) and the EU Directive 2005/36/EC, there are differences mainly in the design of the curriculum, the number of electives offered, elective courses distribution among the pharmacy degree programs, the flexibility of electives' selection and the variety of subjects offered.

In all institutions, core pharmaceutical training is well structured and ensures that graduates have the necessary scientific, clinical and professional skills to practice the pharmacy profession. However, there are significant differences in the position of the core subjects in the curriculum, all courses at the compared institutions are not taught in one semester, the topics of the core subjects are not covered in the same number of courses and the criteria for allocating ECTS to the courses are not uniform.

In order to ensure greater harmonization and mobility of students between University of Belgrade (Serbia), National and Kapodistrian University of Athens (Greece), Poznan University of Medical Sciences (Poland), University of Ljubljana (Slovenia), University of Zagreb (Croatia) and Charles University (Hradec Králové, Czech Republic), it would be advisable to select strategic partner(s) and focus on:

1. Aligning core curricula and credit allocation:

- Standardize the position of core courses in the curriculum.
- Make a strategic agreement that all courses will be taught in one semester.
- Ensure that the topics, critical to developing a student’s ability to apply theoretical knowledge to real-world pharmaceutical practice, are covered in the same number of courses.
- Standardize the criteria for the allocation of ECTS for courses.

2. Enhancing flexibility in electives courses:

- Develop joint electives between universities that allow students to take online or hybrid electives from partner institutions.

3. Strengthening of internationalization and mobility:

- Create joint exchange programs where students can take courses at a partner institution thus facilitating credit transfer.
- Develop a common European competency framework for pharmacy graduates to ensure that qualifications are recognized across borders without the need for additional certification.