

**SEVENTY YEARS OF BIOCHEMICAL SUBJECTS' DEVELOPMENT  
IN PHARMACY CURRICULA: EXPERIENCE FROM SERBIA**SEDAMDESET GODINA RAZVOJA BIOHEMIJSKIH PREDMETA  
U KURIKULUMU FARMACIJE: ISKUSTVO IZ SRBIJEAndrijana Milošević Georgiev<sup>1</sup>, Dušanka Krajnović<sup>1</sup>, Jelena Manojlović<sup>1</sup>,  
Svetlana Ignjatović<sup>1</sup>, Nada Majkić Singh<sup>2</sup><sup>1</sup>University of Belgrade, Faculty of Pharmacy, Belgrade, Serbia<sup>2</sup>Society of Medical Biochemists of Serbia, Belgrade, Serbia**Summary**

**Introduction:** The pharmacists played an important role in the development of biochemistry as applied chemistry in Serbia. What is more, the first seven state chemists in Serbia were pharmacists. State chemists performed the chemical-toxicological analysis as well as some medical and biochemical ones. When it comes to the education of medical biochemists as health workers, the period after the beginning of the second half of the twentieth century should be taken into account because that is when the training of pharmaceutical staff of the Faculty of Pharmacy, University of Belgrade, begins on the territory of Serbia. This paper presents the development of medical biochemistry through the development of curriculum, personnel and literature since the foundation of the Faculty of Pharmacy in Serbia until today.

**Objective:** The aim of this paper is to present the historical development of biochemistry at the Faculty of Pharmacy, University of Belgrade, through analysis of three indicators: undergraduate and postgraduate education of medical biochemists, teaching literature and professional associations and trade associations.

**Method:** The method of direct data was applied in this paper. Also, desktop analysis was used for analyzing of secondary data, regulations, curricula, documents and bibliographic material. Desktop research was conducted and based on the following sources: Archives of the University of Belgrade-Faculty of Pharmacy, Museum of the History of Pharmacy at the University of Belgrade-Faculty of Pharmacy, the Society of Medical Biochemists of Serbia and the Serbian Chamber of Biochemists.

**Kratak sadržaj**

**Uvod:** Značajnu ulogu u razvoju biohemije kao primenjene hemije dali su farmaceuti, pa su čak prvih sedam državnih hemičara u Srbiji bili apotekari. Državni hemičar obavljao je hemijsko-toksikološke analize kao i neke medicinsko-biohemijske analize. O školovanju medicinskih biohemičara kao zdravstvenih radnika može se govoriti od druge polovine XX veka, kada na teritoriji Srbije počinje školovanje farmaceutskog kadra na Farmaceutskom fakultetu u Beogradu. U radu je prikazan razvoj medicinske biohemije kroz razvoj nastavnih planova i programa, stručnog kadra i literature na Farmaceutskom fakultetu u Beogradu od njegovog osnivanja do danas.

**Cilj:** Cilj rada je da se prikaže istorijski razvoj biohemije na Farmaceutskom fakultetu Univerziteta u Beogradu analizom tri indikatora: dodiplomskog i posrediplomskog obrazovanja medicinskih biohemičara; nastavne literature i stručnih udruženja i strukovnih asocijacija.

**Metode:** U radu je primenjena metoda direktnih podataka i, gde je bilo potrebno, korišćena je desktop analiza pomoću koje su analizirani sekundarni podaci, uredbe, nastavni planovi i programi, dokumenta i bibliografska građa. Desktop istraživanje je realizovano na osnovu sledećih izvora: Arhive Univerziteta u Beogradu – Farmaceutskog fakulteta, Muzeja za istoriju farmacije Univerziteta u Beogradu – Farmaceutskog fakulteta, Društva medicinskih biohemičara Srbije i Komore biohemičara Srbije.

**Rezultati i zaključak:** Kroz rezultate prikazani su nastavni planovi i programi, Bolonjski proces unapređenja nastave, širenje opsega predmeta, broj studenata, stručna literatura

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**Results and conclusion:** The curricula, the Bologna process of improving education, the expansion of the range of subjects, the number of students, professional literature for teaching biochemistry, as well as professional associations and trade associations are presented through the results.

**Keywords:** medical biochemistry, pharmacy, education, Serbia

## Introduction

The origins of biochemistry in Serbia are related to the establishment of the State Laboratory of Chemistry in 1859, which was proclaimed a part of Police Ministry's sanitary department by Prince Miloš Obrenović. Hence, the first seven State Chemists of Serbia were apothecaries. Their task was to perform chemical-toxicological analyses, as well as medical-biochemical ones (saliva, urine, blood analyses) for public and legal purposes (1, 2). Apothecaries also performed chemical analyses in pharmacy laboratories, which was regulated as part of their professional duties by the »Law for Pharmacies and Apothecaries on keeping and selling drugs and poisons« of 1865 (Article 24) (3). Considering the lack of possibilities for pharmacy courses to be held in Serbia in Serbian language, pharmacists studied Applied Chemistry at European universities. Adequate schooling of medical biochemists as health-care workers emerges in the second half of the twentieth century, when the education of pharmacists at the Faculty of Pharmacy in Belgrade began. The first attempts in that direction were made through the Law on University (accepted on 27 February 1905), which encompassed a pharmacy course. Unfortunately, until 1937, it remained just an unrealized idea. The establishment of an independent Department of Pharmacy at the School of Medicine was decided by the Regulation Act that concerned medical schools of the universities in Belgrade, Zagreb and Ljubljana. It was opened on 24 October, 1939. It was prescribed by this Regulation Act that Medical Biochemistry should be taught in the 5<sup>th</sup> and 6<sup>th</sup> semester, which was really the beginning of the development of this scientific discipline as a part of pharmaceutical science. This paper shows the development of Medical Biochemistry through the development of curricula, professional staff and the literature from the establishment of the Faculty of Pharmacy to the present day on the territory of Serbia (4, 5).

After the Second World War, during which teaching was interrupted at the School of Medicine, the education of pharmacists continued there and at the Central Laboratory. Shortly after, on 19 October, 1945, the Department of Pharmacy became an independent Faculty of Pharmacy with residence at 8 Dr Subotića Street. Medical Biochemistry with Biochemical Analyses belonged to the Chemistry Chair and it was a 4<sup>th</sup> year's subject in both semesters (the winter semester included one theory class, while the

za nastavu iz biohemije i stručna udruženja i strukovne asocijacije.

**Ključne reči:** medicinska biohemija, farmacija, obrazovanje, Srbija

summer semester contained two theory classes and four classes of laboratory practice a week). Due to the frequent reorganizing of curricula and the faculty's organizational structure, there have been several changes in Medical Biochemistry teaching in the first years of the faculty's independence. In 1947, a separate Institute for Applied Chemistry was formed and it included a course in Toxicological Chemistry, Bromatology and Biochemistry and Clinical Analyses. The first Medical Biochemistry teacher was associate professor Pavle Trpinac. The progress of medical biochemical science is impossible to follow due to the frequent changes of the subject's title and also because this course was only a part of other chairs at the time, since it could not yet become an independent science among the medically oriented chemistry branches. The building of the Pathophysiology Institute of the School of Medicine was the base for theoretical and practical classes for Biochemistry courses. In 1961/62, three departments were formed at the Faculty of Pharmacy: Pharmaceutical-Technological Department, Clinical Biochemistry Department and Sanitary Chemistry Department, but this type of organization lasted only a few years. Students would choose the department they want in the last year of their studies. On the other hand, the diploma was the same for everyone with just a simple notification about the chosen department. During this period, the subject *Basic Biochemistry* was mandatory at all three departments. *Clinical Biochemists* studied also the *Introduction into Clinical Analyses and Medical Biochemistry*. Much later, in 1984, in the fourth year of pharmacy studies, a Clinical Biochemistry course for pharmacists was introduced. Two departments were formed again: Graduated Pharmacist and Graduated Pharmacist – Medical Biochemist (1987). When new curricula were introduced in 2006 according to the Bologna Declaration, these departments became study programs of integrated academic studies that introduced new academic titles – Master of Pharmacy and Master of Pharmacy – Medical Biochemist (Table I) (4–8).

## Objective

The aim of this paper is to show the historical development of Medical Biochemistry subjects within pharmacy curricula through the analysis of three indicators:

1. undergraduate and postgraduate education of Medical Biochemists,

**Table I** Turning points in the history of the Faculty of Pharmacy, University of Belgrade (adapted from ref 4).

Date	Activity/Event
2 October 1905	University of Belgrade is opened; Faculty of Philosophy introduces a Pharmacy course
24 October 1919	Faculty Council Decision on establishing an Apothecary course at the Faculty of Philosophy; the studies last three years after which the title Magister of Pharmacy is obtained
23 July 1921	Decision on joining Pharmaceutical Departments in Zagreb and Belgrade to the Schools of Medicine in those cities; Pharmacy studies last eight semesters
July 1930	University Law by which the Department of Pharmacy is established, as part of the University School of Medicine
27 May 1939	The first meeting of the Council of the Pharmaceutical Department; the first head of the Department of Pharmacy is Professor Rihard Burijan
24 October 1939	Opening of Pharmaceutical Department of the University School of Medicine
19 October 1945	Faculty of Pharmacy established; the first Dean is professor Peter Matavulj
1984	Two departments are introduced: General Pharmacy Department and the Department of Clinical Biochemistry
1987	Departments change names: Graduated Pharmacist and Graduated Pharmacist – Medical Biochemist
1987	Graduation exam is introduced
1991	Studies last five years instead of four
2006	The new study plan in accordance with the Bologna Declaration

2. teaching literature and

3. professional and trade associations

Specific objectives are focused on monitoring the development of human resources as an indicator of the development of Medical Biochemistry. This is achieved through the analysis of the following factors:

i) the increased number of new Medical Biochemistry subjects and monitoring the overall representation of Medical Biochemistry subjects in the curriculum;

ii) monitoring the number of students enrolled in the Department of Medical Biochemistry at

the undergraduate or at certain types of post-graduate studies of Medical Biochemistry;

iii) the improvement of the conditions necessary for the development of Medical Biochemistry as a science.

## Materials and Methods

The historical method (method of direct data) has mostly been used in this paper. However, desktop analysis has also been used where it was necessary, i.e. for the analysis of secondary data, regulations, curri-

cula, documents, and bibliographic material. Desktop research was conducted on the basis of the following sources: The Archives of the University of Belgrade – Faculty of Pharmacy, Museum of History of Pharmacy, University of Belgrade – Faculty of Pharmacy, the Society of Medical Biochemists of Serbia and the Serbian Chamber of Biochemists. A retrospective analysis has been done for the period 1945–2015.

## Results

Medical Biochemistry Department trained personnel to work in the medical-biochemical, toxicological and sanitary laboratories.

### *Curricula and syllabuses*

By analysing the curriculum of the Pharmacy Medical Biochemistry Department, the following results on the number of Medical Biochemistry subjects were obtained (4, 9):

- According to the curricula of 1986 and 1991, the first two years of study contained the same subjects for both the departments.
- In the third year, the Pharmacy – Medical Biochemistry Department introduced several sub-

jects: *Biostatistics, Clinical – Chemical Laboratory Methods, and Immunochemistry*, while in the fourth year *Laboratory Hematology, Clinical Chemistry, Control of Food Safety, Clinical – Toxicological Analysis and Clinical Enzymology* were added.

- *General Biochemistry and Medical Biochemistry* were taught as subjects in both curricula (1986/87 and 1991/92) (Tables II and III).
- When the curriculum was changed in 1991, the number of both theoretical and practical classes increased for the *General Biochemistry* subject, while for the *Medical Biochemistry* subject theoretical teaching slightly decreased, as opposed to the practical teaching that increased almost twice (Figure 1).

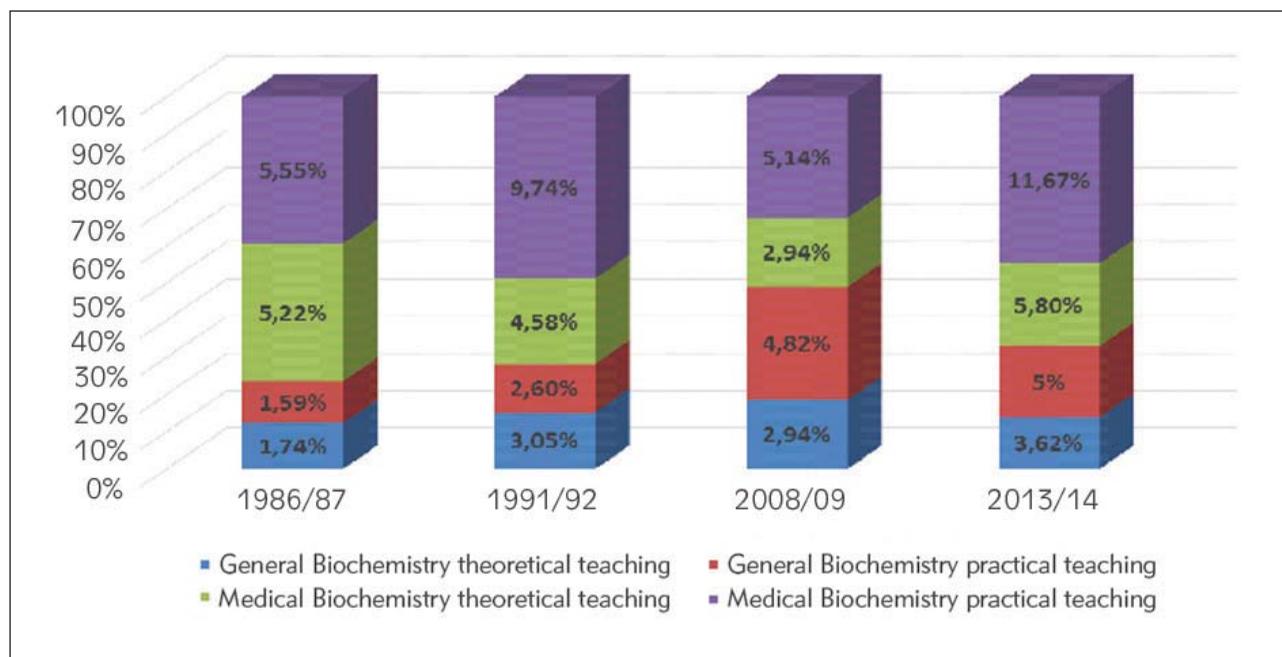
#### The Bologna process of improving teaching

The recent University reform in accordance with the Bologna process, which also included the reform of the Faculty of Pharmacy, shows that *Medical Biochemistry* is a science that still has the potential to expand and to develop. The Department of *Medical Biochemistry* has far more *Biochemistry* subjects today than the Department for the *Master of Pharmacy*. It clearly shows that these two departments differ significantly and can develop independently. Nine mandatory *Medical Biochemistry* subjects and 7 optional subjects (Table IV) have been included in the curri-

culum at the Department of *Medical Biochemistry* (2008/09). Mandatory subjects are: *Introduction to the Study of Medical Biochemistry, General Biochemistry, Medical Biochemistry, Hematology, Statistics, Clinical Chemistry with Molecular Diagnostics, Laboratory Methods in Hematology, Clinical Enzymology, and Laboratory Statistics*. They account for 26.33% of the total student workload expressed through ECTS. Optional subjects include: *Application of Information Technology in Academic and Professional Practice, Risk Factors for Cardiovascular Disease, Laboratory Diagnosis of Endocrinopathy of the Reproductive System, Biochemical Methods in Prenatal Diagnosis, Laboratory Diagnosis of Hemostatic Disorders, Laboratory Management and Quality Assurance, and Evidence Based Laboratory Medicine* (8, 10, 11). Also, 11 mandatory *Medical Biochemistry* subjects and 8 optional subjects (Table V) have been included in the latest curriculum for the Department of *Medical Biochemistry* (2013/14).

#### Subjects

From the very beginning, *Medical Biochemistry* subjects had a certain role in the education of pharmacists. Several subjects of *medical biochemistry* emerged in the four-year curriculum of schooling which remained unchanged until 1991. *General Biochemistry* is a subject in the 5<sup>th</sup> semester at the Department of Pharmacy according to the five-year plan of study (only theoretical teaching, without practical lessons), while *Medical Biochemistry* is included



**Figure 1** Percentage of theoretical and practical lessons in *General Biochemistry* and *Medical Biochemistry* in the syllabus during the four- and five-year courses of study.

**Table II** Curriculum for the academic year 1986/87 at the University of Belgrade, Faculty of Pharmacy – program for Medical Biochemistry.

Subjects in the school year 1986/87 (number of theoretical classes + practical teaching)	Winter Semester	Spring Semester
Biology (2+1)	I	
Mathematics (3+4)	I	
Fundamentals of Marxism (4+1)	I	
General and Inorganic Chemistry (6+4)	I	II
ONO I (2+0)	I	II
Physics (6+5)	I	II
Physical Education (0+4)	I	II
Botany (4+5)	I	II
Foreign Language (2+2)	I	II
Fundamentals of Organic Chemistry (3+0)		II
Self-managing Socialism (3+1)		II
Anatomy with Histology (2+2)		II
Physiology (4+3)	III	IV
Foreign language (2+2)	III	IV
Analytical Chemistry (4+15)	III	IV
Physical Chemistry and Instrumental Methods (5+7)	III	IV
Organic Chemistry (4+11)	III	IV
ONO II (2+2)	III	IV
Biostatistics* (2+1)	V	
Clinical-Chemical Laboratory Methods (2+3)	V	
Immunology (2+2)	V	
Pharmaceutical Chemistry (4+6)	V	VI
Pathological Physiology (4+0)	V	VI
Microbiology (2+2)		VI
General Biochemistry * (3+0)		VI
Immunochemistry (2+2)		VI
Laboratory Hematology * (2+2)	VII	
Medical Ethics (2+1)	VII	
Pharmacokinetics (2+2)	VII	
Toxicological Chemistry (5+8)	VII	VIII
Pharmacology (6+0)	VII	VIII
Clinical Chemistry * (6+8)	VII	VIII
Control of Food Safety *** (3+6)	VII	VIII
Medical Biochemistry* (6+7)	VII	VIII
Clinical Enzymology * (3+4)		VIII
Clinical and Toxicological Analysis** (1+3)		VIII
Graduation	/	/

Note: \* subject relevant for Medical Biochemistry and realised by the Department of Biochemistry; \*\* subject relevant for Medical Biochemistry and realised by the Department of Toxicology; \*\*\* subject relevant for Medical Biochemistry and realised by the Department of Bromatology

**Table III** Curriculum for the academic year 1991/92 at the University of Belgrade, Faculty of Pharmacy – program for Medical Biochemistry.

Subjects in the school year 1986/87 (number of theoretical classes + practical teaching)	Winter Semester	Spring Semester
Biology and Human Genetics (3+2)	I	I
Mathematics (4+6)	I	II
Fundamentals of Organic Chemistry (5+0)	I	II
General and Inorganic Chemistry (6+6)	I	II
Physics (6+5)	I	II
Sociology (4+0)	I	II
Physical Education (0+4)	I	II
Anatomy with Histology (2+2)		II
Foreign Language (2+2)	I	II
General Biochemistry* (4+4)	III	IV
Organic Chemistry (4+11)	III	IV
Foreign Language (2+2)	III	IV
Physiology (5+3)	III	IV
Physical Chemistry and Instrumental Methods (6+4)	III	IV
Analytical Chemistry (5+14)	III	IV
Clinical-Chemical Laboratory Methods (3+4)	V	
Immunology (2+2)	V	
Pharmaceutical Chemistry (8+14)	V	VI
Pathological Physiology (4+0)	V	VI
Microbiology (4+3)		VI
Immunochemistry (2+2)		VI
Laboratory Hematology* (3+3)		VI
History of Pharmacy with Ethics (2+0)	VII	
Toxicological Chemistry (5+8)	VII	VIII
Bromatology (3+5)	VII	VIII
Pharmacology (7+3)	VII	VIII
Medical Biochemistry* (6+15)	VII	VIII
Statistics in Medical Biochemistry* (2+2)		VIII
The Technology with Biopharma (2+0)		VIII
Pharmacokinetics (3+3)	IX	
Clinical and Toxicological Analysis** (2+4)	IX	
Control of Food Safety*** (4+8)	IX	X
Clinical Chemistry* (6+9)	IX	X
Organization of Pharmaceutical Activity (2+0)		X
Clinical Enzymology* (3+4)		X
Graduation	/	/

Note: \* subject relevant for Medical Biochemistry and realised by the Department of Biochemistry; \*\* subject relevant for Medical Biochemistry and realised by the Department of Toxicology; \*\*\* subject relevant for Medical Biochemistry and realised by the Department of Bromatology

**Table IV** Curriculum for the academic year 2008/09 at the Faculty of Pharmacy, University of Belgrade – program for Medical Biochemistry.

SUBJECT (THE TYPE OF SUBJECT: O – mandatory, I – optional, ESPB – European Credit Transfer System)				
I year	II year	III year	IV year	V year
<i>Biology and Human Genetics</i> (O, 6)	<i>Immunology with Immunochemistry</i> (O, 6)	<i>Pharmacology</i> (O, 11)	<i>Bromatology</i> (O, 7)	<i>Clinical Enzymology</i> (O, 5)
<i>Mathematics</i> (O, 4)	<i>Analytical Chemistry II</i> (O, 8)	<i>Medical Biochemistry</i> (O, 22)	<i>Pharmacokinetics</i> (O, 6)	<i>Clinical and Toxicological Analysis</i> (O, 5)
<i>Organic Chemistry</i> (O, 6)	<i>Instrumental Methods</i> (O, 6)	<i>Pathophysiology</i> (O, 8)	<i>Toxicology with Analytics</i> (O, 11)	<i>Control of Food Safety I</i> (O, 5)
<i>General and Inorganic Chemistry</i> (O, 6)	<i>Physiology</i> (O, 10)	<i>Hematology</i> (O, 4)	<i>Clinical Chemistry with Molecular Diagnostics</i> (O, 18)	<i>Laboratory Diagnosis of Disorders of Hemostasis</i> (I, 6)
<i>Physics</i> (O, 4)	<i>General Biochemistry</i> (O, 14)	<i>Statistics</i> (O, 3)	<i>Ethics and Legislation</i> (O, 2)	<i>Dietetics</i> (I, 6)
<i>Bioorganic Chemistry</i> (O, 6)	<i>Pharmaceutical Chemistry</i> (O, 6)	<i>Free Radicals and Antioxidants Laboratory Diagnosis</i> (I, 6)	<i>Laboratory Methods in Hematology</i> (O, 4)	<i>Ecotoxicology</i> (I, 6)
<i>Analytical Chemistry I</i> (O, 5)	<i>Microbiology</i> (O, 7)	<i>Assets that are Addictive with Analytics</i> (I, 6)	<i>Selected topics Genotoxicology</i> (I, 6)	<i>Assessment of Risk to Human Health</i> (I, 6)
<i>Introduction to the Study of Medical Biochemistry</i> (O, 5)	<i>Application of Information Technology in Academic and Professional Practice</i> (I, 3)	<i>Risk Factors for Cardiovascular Disease</i> (I, 6)	<i>Laboratory Diagnosis of Endocrinopathy of Reproductive System</i> (I, 6)	<i>Control of Food Safety II</i> (O, 5)
<i>Anatomy with Histology</i> (O, 5)	<i>Foreign Language in Professional Practice</i> (I, 3)	<i>Physiology and Pathophysiology of Aging</i> (I, 6)	<i>Acute Poisoning with Drugs Analytics</i> (I, 6)	<i>Laboratory Statistics</i> (O, 4)
<i>Physical Chemistry</i> (O, 5)			<i>Biochemical Methods in Prenatal Diagnosis</i> (I, 6)	<i>Fundamentals of Health Management</i> (O, 2)
<i>Foreign Language</i> (O, 6)				<i>Laboratory Management and Quality Assurance</i> (I, 5)
				<i>Evidence Based Laboratory Medicine</i> (I, 5)
				<i>Indicators of Environmental Pollution and Sustainable Development</i> (I, 5)
				<i>Health Safety of General Use</i> (I, 5)

**Table V** Curriculum for the academic year 2013/14 at the Faculty of Pharmacy, University of Belgrade – program for Medical Biochemistry.

SUBJECT (THE TYPE OF SUBJECT: O – mandatory, I – optional, ESPB – European Credit Transfer System)				
I year	II year	III year	IV year	V year
<i>Biology and Human Genetics</i> (O, 5)	<i>Immunology with Immunochemistry</i> (O, 6)	<i>Pharmacology II</i> (O, 6)	<i>Control of Food Safety I</i> (O, 5)	<i>Clinical Chemistry with Molecular Diagnostics II</i> (O, 10)
<i>Mathematics</i> (O, 4)	<i>Analytical Chemistry II</i> (O, 5)	<i>Medical Biochemistry I</i> (O, 10)	<i>Pharmacokinetics</i> (O, 6)	<i>Clinical and Toxicological Analysis</i> (O, 5)
<i>Organic Chemistry</i> (O, 7)	<i>Instrumental Methods</i> (O, 6)	<i>Pathophysiology II</i> (O, 5)	<i>Toxicology with Analytics</i> (O, 5)	<i>Control of Food Safety II</i> (O, 5)
<i>General and Inorganic Chemistry</i> (O, 5)	<i>Physiology II</i> (O, 5)	<i>Hematology</i> (O, 4)	<i>Clinical Chemistry with Molecular Diagnostics I</i> (O, 7)	
<i>Physics</i> (O, 3)	<i>General Biochemistry I</i> (O, 8)	<i>Statistics</i> (O, 3)	<i>Clinical Enzymology</i> (O, 5)	
<i>Bioorganic Chemistry</i> (O, 6)	<i>Pharmaceutical Chemistry</i> (O, 6)	<i>Bromatology</i> (O, 8)		
<i>Analytical Chemistry I</i> (O, 4)	<i>Microbiology</i> (O, 6)	<i>Pharmacology III</i> (O, 5)		
<i>Introduction to the Study of Medical Biochemistry</i> (O, 5)	<i>General Biochemistry II</i> (O, 6)	<i>Medical Biochemistry II</i> (O, 10)		
<i>Physical Chemistry</i> (O, 5)	<i>Pharmacology I</i> (O, 4)	<i>Laboratory Hematology</i> (O, 4)		
<i>Functional Morphology of the Human</i> (O, 5)	<i>Pathophysiology I</i> (O, 5)			
<i>Physiology I</i> (O, 5)				
<i>Foreign Language in Professional Practice</i> (I, 2)	<i>Selected chapters of Physiology</i> (I, 3)	<i>Free Radicals and Antioxidants Laboratory Diagnosis</i> (I, 2)	<i>Ethics and Legislation</i> (I, 3)	<i>Prenatal Diagnosis and Screening in Pregnancy</i> (I, 4)
<i>Introduction to Laboratory Work</i> (I, 2)	<i>Colloid Chemistry</i> (I, 3)	<i>Laboratory Microbiology</i> (I, 2)	<i>Ecotoxicology</i> (I, 3)	<i>The Toxicology Practice</i> (I, 4)
<i>Selected Chapters of Organic Chemistry</i> (I, 4)		<i>Risk Factors for Cardiovascular Disease</i> (I, 3)	<i>Acute Poisoning with Drugs Analytics</i> (I, 3)	<i>Chemical Carcinogens</i> (I, 4)
<i>Application of IT Methods in Medical Biochemistry</i> (I, 4)		<i>Assets that are Addictive with Analytics</i> (I, 3)	<i>Laboratory Diagnosis of Endocrinopathy of Reproductive System</i> (I, 3)	<i>Biochemistry of Sport</i> (I, 4)
			<i>Laboratory Diagnosis of Thrombophilia</i> (I, 3)	<i>Laboratory Management and Quality Assurance</i> (I, 4)
			<i>The Use of Radionuclides in Biochemistry, and Protection Measures</i> (I, 3)	<i>Modern Methods in Medical Biochemistry</i> (I, 4)
				<i>Assessment of Risk to Human Health</i> (I, 4)
				<i>Health Safety of General Use</i> (I, 4)
<i>Professional Practice</i> (0, 10)				
<i>Final Work</i> (0, 14)				

in the ninth and the tenth semester. The Department of Pharmacy – Medical Biochemistry additionally included *Clinical Chemistry*, *Hematology* and *Clinical Enzymology* (Table VI). Contents of these subjects vary greatly, although they are common subjects for both departments of the Faculty of Pharmacy. At the beginning of the Medical Biochemistry development at the Faculty of Pharmacy (1946), only two from a total of 23 subjects were biochemical. Today, the number has increased to nine of the total of 37 subjects.

### Students

In the beginning, the number of students at the Faculty of Pharmacy was not limited and depended on the number of interested candidates. Later, the number was limited by the Decisions of the University of Belgrade. Table VII shows the number of students enrolled in all the departments of the Faculty of Pharmacy, University of Belgrade, during the years 1945–2013 and the sex ratio of students enrolled for each year. At the Department of Medical Biochemistry (Table VII), the number of enrolled students was fairly similar from year to year in the period 1999–2013 (12).

### Professional literature for teaching Biochemistry

The scientific literature used to be in the form of collections of selected texts in the beginning of the faculty's development. There was not enough material for writing extensive and detailed books and textbooks. As time went by, the range of Medical Biochemistry subjects increased thus increasing the amount of teaching material and the number of professional staff. Consequently, a clear increase in the amount of literature has been evident in recent years (Figure 2) (4, 5, 13–15).

### Professional development and organizations

A student who has successfully completed the integrated graduate studies, the programme Master of Pharmacy – Medical Biochemistry, acquires a high education degree and the academic title of Master of Pharmacy – Medical Biochemist. After graduation, it is

possible to enroll in any kind of post-graduate studies, specialist or PhD studies at the Faculty of Pharmacy. Specialist studies in Medical Biochemistry are part of medical specializations and they last 4 years. In order to enroll in this course, one should get the approval of the Serbian Ministry of Health, on the basis of a request from the director of the organization in which the applicant medical biochemist works, according to the *Rules and Regulations On the Health Care Specialization studies*. These rules have been introduced in 1960 and are still in the focus of Biochemistry graduates. There are also three sub-specialisations available to clinical medical biochemists: Laboratory Endocrinology, Clinical Enzymology and Clinical Immunochemistry. The Faculty of Pharmacy in Belgrade also organizes specialist academic studies: Biochemical Diagnosis. The Faculty of Pharmacy organizes PhD studies in Medical Biochemistry, which last 3 years. Each year, a number of graduate students is enrolled. A student who completes his/her PhD academic studies acquires the scientific title Doctor of Medical Science – Pharmacy (Doctor of Pharmaceutical Science) (Figure 3) (8).

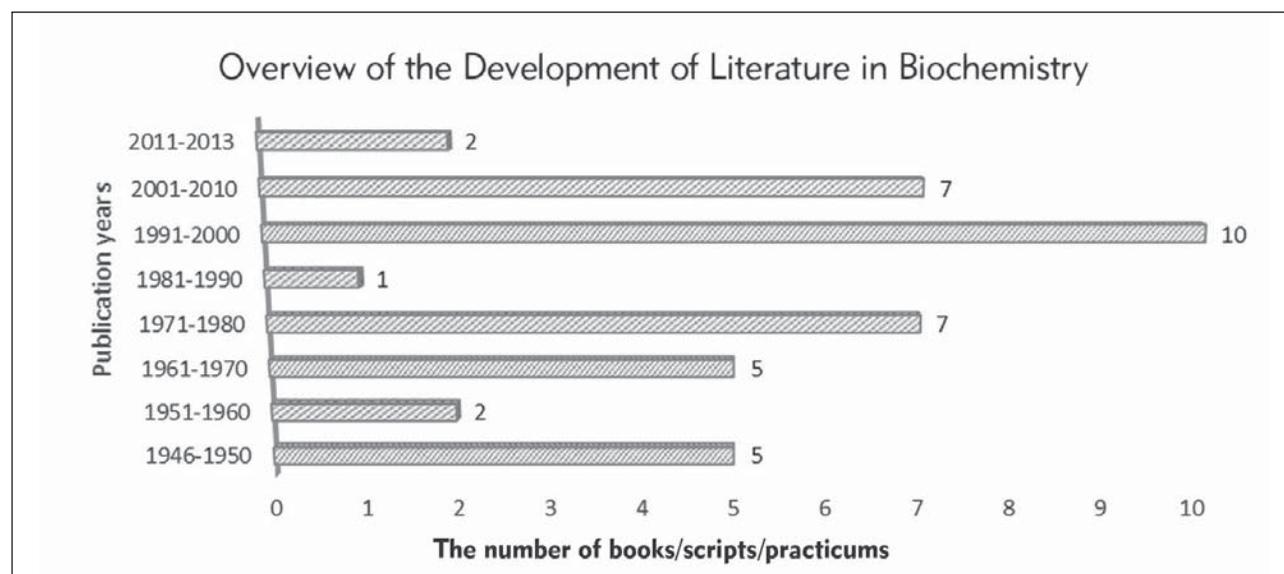
With the increasing number of enrolled – graduate medical biochemists, there came the need for the establishment of professional associations. The advance of every scientific field increases the number of professionals interested in it. However, certain kinds of professional societies and associations need to be formed so as to unite the interested parties and to regulate both professionally and ethically the labour acts and the behaviour of the employees in performing their duties. The following ones are important for Biochemistry as a science in Serbia: Society of Medical Biochemists of Serbia (DMBS), the Chamber of Biochemists of Serbia and the Section of Medical Biochemistry within the Pharmaceutical Association of Serbia. The first professional association was the Section of Medical Biochemistry, Pharmaceutical Association of Yugoslavia, which was founded in Split, 15 May 1955, which is the date later chosen for the Day of the Society of Medical Biochemists of Serbia. This is a professional organization that brings together medical biochemists in order to improve and develop Medical Biochemistry in all the areas of health care. One of the aspects of the exchange of new knowledge is the »Journal of Medical Biochemistry«, issued quarterly by the Society, as well as its member-

**Table VI** Biochemistry subjects in the five-year syllabus from 1991 till the Bologna reform in 2006 at the Belgrade University Faculty of Pharmacy.

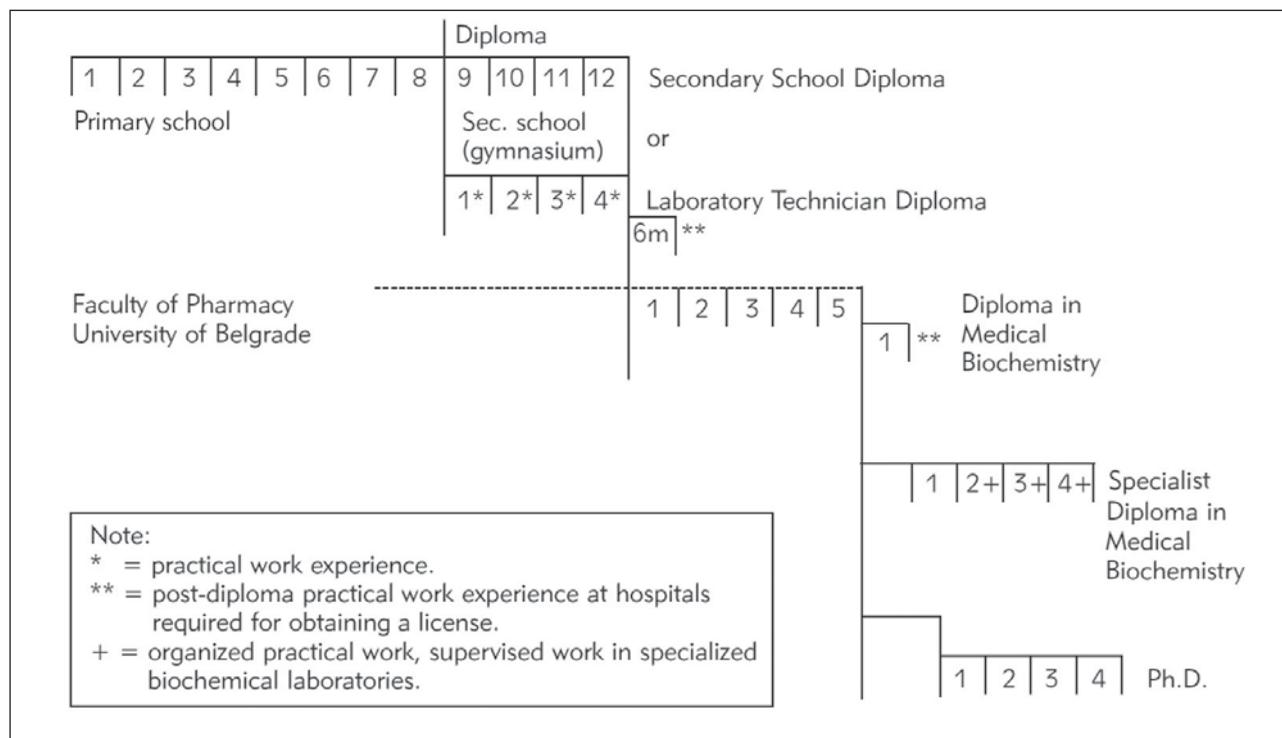
	V semester	VI semester	VII semester	VIII semester	IX semester	X semester
Pharmacy	<i>General Biochemistry</i>				<i>Medical Biochemistry</i>	<i>Medical Biochemistry; Statistics in Pharmacy</i>
Pharmacy Medical Biochemistry	<i>General Biochemistry</i>	<i>General Biochemistry</i>	<i>Medical Biochemistry; Hematology</i>	<i>Medical Biochemistry</i>	<i>Clinical Chemistry</i>	<i>Clinical Chemistry; Clinical Enzymology; Statistics in Medical Biochemistry</i>

**Table VII** The number of students enrolled in the first year of bachelor studies for the academic period 1945–2013.

Number of students by gender (DF+MB) between 1954–2013											
Years of enrollment	W	M	Total	Year of enrollment	W	M	Total	Year of enrollment	W	M	Total
1945/46	166	68	234	1970/71	190	25	215	1995/96	344	51	395
1946/47	169	85	254	1971/72	216	50	266	1996/97	375	85	460
1947/48	157	81	238	1972/73	189	44	233	1997/98	404	69	473
1948/49	111	67	178	1973/74	182	35	217	1998/99	394	91	485
1949/50	111	62	173	1974/75	243	46	289	1999/00	431	85	516
1950/51	128	54	182	1975/76	248	52	300	2000/01	366	75	441
1951/52	158	78	236	1976/77	244	51	295	2001/02	270	39	309
1952/53	166	66	232	1977/78	218	40	258	2002/03	266	44	310
1953/54	63	18	81	1978/79	264	52	316	2003/04	285	36	321
1954/55	107	55	162	1979/80	238	59	297	2004/05	275	47	322
1955/56	86	51	137	1980/81	296	25	321	2005/06	277	51	328
1956/57	53	13	66	1981/82	299	61	360	2006/07	275	54	329
1957/58	68	38	106	1982/83	255	53	308	2007/08	273	62	335
1958/59	79	35	114	1983/84	229	73	302	2008/09	283	54	337
1959/60	89	33	122	1984/85	208	47	255	2009/10	272	69	341
1960/61	152	60	212	1985/86	178	33	211	2010/11	268	60	328
1961/62	128	34	162	1986/87	234	37	271	2011/12	267	49	316
1962/63	141	43	184	1987/88	221	49	270	2012/13	275	60	335
1963/64	93	43	136	1988/89	240	36	276	2013/14	283	59	342
1964/65	110	46	156	1989/90	224	35	259				
1965/66	142	48	190	1990/91	237	42	279				
1966/67	135	21	156	1991/92	268	37	305				
1967/68	141	17	158	1992/93	221	56	277				
1968/69	156	26	182	1993/94	271	30	301				
1969/70	161	21	182	1994/95	305	40	345				



**Figure 2** Overview of the development of literature in Biochemistry.



**Figure 3** Educational outline of the Medical Biochemist in Serbia (adapted from ref 4).

**Table VIII** Number of students enrolled in the first year at the Medical Biochemistry Department (MB) in the period between 1999–2014.

Number of students at MB			
Year of enrollment	Total	Year of enrollment	Total
1999/00	58	2007/08	60
2000/01	58	2008/09	64
2001/02	62	2009/10	66
2002/03	61	2010/11	66
2003/04	62	2011/12	65
2004/05	66	2012/13	68
2005/06	65	2013/14	76
2006/07	69	2014/15	

ship in the International Federation of Clinical Chemistry and Laboratory Medicine, European Federation of Clinical Chemistry and Laboratory Medicine and the Balkan Federation for Laboratory Medicine. As a professional organization recognized by the Law on Chambers of Health Workers («Official Gazette of RS», No. 107/05) the Serbian Chamber of Biochemists was formed. Its main aim is to improve and regulate the conditions needed for carrying out medical-biochemical activities, to supervise the professional work and to provide licences for independent work (5, 15–18).

## Discussion and Conclusion

Not only have the curricula been enriched with contents on Clinical Chemistry, but the number of practical classes in Medical Biochemistry subjects has also been increased. This gives significance to practical teaching in gaining laboratory skills that are to be used by medical biochemists along with the theoretical knowledge in their professional work after they get the licence. The fast advance of Medical Biochemistry science can be seen in the increased number of mandatory subjects, as well as in their expanded scope. There is, also, the introduction of a new kind of subjects, optional ones, 16 altogether for different sub-categories of the science of Medical Biochemistry.

The number of Medical Biochemistry subjects has been increased over the years, in accordance with the changes in curriculum. In the very beginning, in the school year 1945/46, only one subject of the total of twenty was biochemical (5%). When studying the development of Biochemistry through the curricula, the increase in Biochemistry subjects is evident. In 1986/87, 17.14% belonged to the biochemical orientation, or 6 from the total of 35 subjects, while in 1991/92, the percentage was 17.65, or 6 from the total of 34. The introduction of a new curriculum for bachelor studies significantly increased the overall number of subjects due to their division into mandatory and optional ones. In 2008/09, 24.32% (37/9) of Biochemistry subjects were mandatory, while 38.89% (18/7) belonged to the optional group.

In the past 13 years, the average number of students enrolled per year was 63.23. The lowest number of students was enrolled at the beginning of 1999/00 (58). However, as time went by, the number of interested and enrolled students increased. The largest number of students in this period was noted in 2006/07, when 69 students enrolled. The highest number of enrolled students coincides with the beginning of the implementation of the Bologna process at the Faculty of Pharmacy in Belgrade (2006/07).

Based on the results previously discussed, it can be concluded that the development of the profession of Medical Biochemist in Serbia is noticeable and closely related to pharmaceutical science and practice. This is reflected not only in the establishment of the new educational profile of Medical Biochemist within pharmaceutical studies and the gradual increase in the number of students interested in such studies, but

also in the fact that this was accompanied by the development of professional literature and by the emergence of professional associations. At the beginning of the development of Medical Biochemistry as a science within the pharmaceutical profession, there existed only a few subsidiary books and authorized notes, while today several textbooks are available for each subject, which is clear evidence of the progress and advancement of this discipline.

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### Conflict of interest statement

The authors stated that they have no conflicts of interest regarding the publication of this article.

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