FACULTY OF PHARMACY

STUDY PROGRAM PHARMACY

CHAIR OF PHARMACOGNOSY AND PHARMACEUTICAL BOTANY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum in Pharmacy
Minutes No. 2 of 09.11.2021
Chairman, associate professor, PhD of pharmacy
Uncu Livia _____

APPROVED
at the Council meeting of the Faculty of Pharmacy
Minutes No 3 of 16.12.2021
Dean of Faculty, associate professor, PhD of pharmacy
Ciobanu Nicolae _____

APPROVED
at the meeting of the Chair of pharmacognosy and pharmaceutical botany
Minutes No. 27 of 30.06.2021
Head of chair, professor, Dr. hab. of biol.
Calalb Tatiana _____

SYLLABUS

DISCIPLINE **FREE RADICALS AND ANTIOXIDANT SYSTEMS IN PHARMACY**

Integrated studies

Type of course: **Free choice discipline**

Curriculum was elaborated by author:

Benea Anna, university assistant

Chisinau, 2021

I. INTRODUCTION

- **General presentation of the discipline: place and role of the discipline in the formation of the specific competences of the professional / specialty training program**
  Free radicals and antioxidant systems in pharmacy is a component in pharmacy education with the objective of knowing what free radicals are, the origin of free radicals, types of free radicals, sources of their production, mechanisms of action of free radicals and defense mechanisms of the body against them. Theoretical knowledge will serve as a basic support to the subjects: Pharmacognosy (3rd year) especially in chemical analysis of plant products and determination of plant sources with high antioxidant properties; Phytotherapy (3rd year); Drug Technology (3rd year) – sources of plant raw material in the production of phytopreparations with antioxidant activity, medicinal species; Aromatherapy (2nd year); Alternative and complimentary phytotherapy (3rd year), Pharmacology, Pharmaceutical Chemistry etc. The knowledge and skills acquired in the subject Free radicals and antioxidant systems in pharmacy will contribute to the preparation of the pharmacist for pharmaceutical and research activity in the field of the use of products of plant and animal origin as sources of compounds with antioxidant potential.
- **Mission of the curriculum (aim) in professional training**
  The discipline requires the acquisition of knowledge about free radicals, the role of antioxidants in protecting the body against oxidative stress, the importance of the study of radical processes for modern pharmacy, methods of total capacity assessment
- Languages of the course: Romanian, English
- Beneficiaries: students of the IIIrd year, faculty of Pharmacy

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline			
Name of the discipline		**Free radicals and antioxidant systems in pharmacy**	
Person in charge of the discipline		**Anna Benea, university assistant**	
Year	**III**	Semester	**V**
Total number of hours, including:			**60**
Lectures	**15**	Practical/laboratory hours	**-**
	30	Self-training	**15**
Form of assement	**E**	Number of credits	**2**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study the student will be able to:

- ***at the level of knowledge and understanding:***

✓ principles of free radicals generated in biological systems;
✓ principles of physiological and pathophysiological processes related to free radicals;
✓ knowledge of natural sources of chemical compounds with antioxidant properties;
✓ mechanisms of action of antioxidants;
✓ methods for evaluating antioxidant activity.

- ***at the application level:***

✓ correct use of the concepts: free radicals, oxidative stress, chemical compound, antioxidant activity;
✓ identification of sources of free radicals;
✓ knowledge of the mechanisms of action of antioxidants;
✓ identification of natural sources of chemical compounds with antioxidant properties (vitamins, carbohydrates, flavonoids, tannins, organic and phenolic acids);
✓ exploiting the benefits of natural antioxidants.

- ***at the integration level:***

✓ develop skills in identifying natural sources with antioxidant properties;
✓ propose applications of antioxidants in the pharmaceutical and cosmetic industries;
✓ to contribute to the consultation of doctors and the public on natural sources of antioxidants;
✓ to inform the public about factors influencing the formation of free radicals and the role of antioxidants in human health;
✓ promote healthy nutrition to protect the body from free radicals.

IV. PROVISIONAL TERMS AND CONDITIONS

The third year student requires the following:

✓ knowledge of the language of instruction;
✓ knowledge in related disciplines such as: pharmaceutical botany, pharmaceutical chemistry, physiology, pharmacognosy, pharmacology;
✓ skills in modern information technology (identification and processing of information, preparation of electronic spreadsheets and presentations, use of graphics software);
✓ communication and teamwork skills.

IV. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/ laboratory hours/seminars and self-training

Nr. d/o	THEME	Number of hours		
		Lectures	Seminars	Self-training
1.	Free radicals definision. The names and types of free radicals. Sources of free radicals.	2	2	1

Nr. d/o	THEME	Number of hours		
		Lectures	Seminars	Self-training
2.	Effects of free radicals on the body. The beneficial activities of free radicals. Destructive activities of free radicals. Oxidative stress.	1	2	1
3.	Antioxidants definition. Structure of the antioxidant system, characteristics of its functioning, main indicators. Classification of antioxidants. Mechanisms of action of antioxidants.	1	2	1
4.	Chemical classification of plant compounds: phenolic compounds, vitamins, alkaloids, terpenes, etc. Particular features of the antioxidant activity of different groups of antioxidants.	1	2	1
5.	Methods for the determination of the antioxidant activity of natural compounds in plant and extractive products in pharmacy (DPPH, ABTS, ORAC, FRAP, etc.).	1	2	1
6.	Natural sources of vitamins with antioxidant properties.	1	2	1
7.	Natural sources containing flavonoids with antioxidant properties.	2	4	2
8.	Natural sources containing phenolic acids with antioxidant properties.	1	3	1
9.	Natural sources containing tannins with antioxidant properties.	1	3	1
10.	Natural sources containing terpenes with antioxidant properties.	1	2	1
11.	Natural sources containing alkaloids with antioxidant properties.	1	2	2
12.	The role and benefits of antioxidants in human health.	2	4	2
Total		**15**	**30**	**15**

VI. PRACTICAL ABILITIES PURCHASED AT THE END OF THE COURSE

The essential compulsory practical skills are:

- develop skills in identifying natural sources with antioxidant properties;
- propose applications of antioxidants in the pharmaceutical and cosmetic industries;
- to contribute to the consultation of doctors and the public about natural sources of antioxidants; about their role in human health;
- promote healthy nutrition to protect the body from free radicals.

VII. REFERENCE OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Theme 1. Free radicals. Classification. Oxidative stress.	
• to define free radicals; • to know the types of free radicals; • to identify sources of free radicals; • to know the negative effects of free radicals on the body; • to understand how oxidative stress occurs; • to know the beneficial activities of free radicals.	Free radicals definition. Names and types of free radicals. Sources of free radicals. The effects of free radicals on the body. The destructive activities of free radicals and their positive role in organisms. Oxidative stress.

Objectives	Content units
Theme 2. Antioxidants. Classification of antioxidants. Methods for determining antioxidant activity.	
• to define the notion of antioxidant; • to know the structure of the human oxidative system; • to know the characteristics of the functioning of the oxidative system; • to know the chemical compounds of plant origin with antioxidant properties; • to become familiar with methods for determining the antioxidant activity of natural compounds.	Antioxidants definition. Structure of the antioxidant system, characteristics of its functioning, main indicators. Classification of antioxidants. Mechanisms of action of antioxidants. Chemical classification of plant compounds: phenolic compounds, vitamins, alkaloids, terpenes. Methods for determining the antioxidant activity of natural compounds in plant products and extracts in pharmacy (DPPH, ABTS, ORAC, FRAP, etc.).
Theme 3. Natural sources of plant chemical compounds with antioxidant properties. The role and benefits of antioxidants in human health.	
• to know primary and secondary chemical compounds of plant origin with antioxidant properties; • to understand the role and benefits of antioxidants in human health.	Natural sources containing chemical compounds of plant origin with antioxidant properties: - vitamins, - flavonoids, - phenolic acids, - tannins, - terpenoids, - alkaloids. The role and benefits of antioxidants in human health.

VIII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY OUTCOMES

✓ Professional (specific) (SC) competences

- PC1. Understand and use chemical, botanical, pharmacognostic terminology; knowledge of free radicals, oxidative stress, antioxidants. Knowledge of the main types of free radicals generated in living systems, classification of reactive oxygen species (ROS), active forms of oxygen, characteristics of damage to molecular and cellular structures..
- PC2. Knowledge of methods and techniques for determining the antioxidant activity of plant and extractive products; identification of medicinal plant products, fruits and vegetables containing primary and secondary compounds (vitamins, flavonoids, phenolic acids, tannins, alkaloids, etc.) with antioxidant properties.
- PC3. Use and adaptation of theoretical knowledge obtained in the optional subject Free radicals and antioxidant systems in pharmacy to phytochemical analysis in the subject Pharmacognosy. Use of theoretical and practical knowledge in becoming a specialist pharmacist making professional activity more efficient by introducing innovative elements in the pharmaceutical field.

✓ Transversal competences (TC)

- TC1. Responsible execution of professional tasks with the application of values and rules of professional ethics, tendency to perfect knowledge and practical skills, selection of digital materials, critical analysis and formulation of conclusions, observance of ethical and deontological rules.
- TC2. Forming the right personal attitude towards the study process, promoting the spirit of initiative, the ability to work in a group and respect for colleagues.
- TC3. Effective use of language skills, creative potential, knowledge in information technologies, research skills for self-development, self-actualization, and self-education.

✓ **Study outcomes**

By the end of the course Free radicals and antioxidant systems in pharmacy a student will be capable:

- Know the criteria for classifying free radicals and antioxidants.
- Identify sources of free radicals and sources of plant chemical compounds with antioxidant properties.
- Explain the therapeutic effects of plant products, extracts and phytopreparations with antioxidant properties, using knowledge of the processes and molecular structures of free radicals and antioxidants.
- Know the mechanisms of action of antioxidants.
- Know the antioxidant role of primary and secondary substances from plant sources and their benefits in human health.
- Be able to prepare independently a spoken report on topics in the programme, followed by discussion.
- Be competent to use the knowledge gained in the discipline Free Radicals and Antioxidant Systems in Pharmacy in the further study of pharmacognosy, toxic plants and phytotherapy.

Note. Study outcomes (are deduced from the professional competencies and formative valences of the informational content of the discipline).

IX. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Thematic Reports	Search, analyses, generalization, and coherent presentation of the information acquired	The quality of systematization and analyses of the informational material acquired through individual activity	During the semester
2.	Case studies	Establishing students' contact with complex, authentic reality in the respective topic with the aim of their familiarization with	Capacity of systematization and consolidation of the knowledge acquired in the class. Assessment of the knowledge application in	During the semester

		possible aspects and in order to develop decisional, operative, and optimal skills and capacity to solve eventual similar cases. Description and critical analyses of the case studies.	real situations created.	
3.	Development of the portfolio (intoxication with poisonous plants, statistical data, treatment schemes in the case of intoxication with poisonous plants etc.)	The development implies three formats: paper (folders with informative material), hybrid (folders with informative material, pictures, video, audio material etc), and electronic/digital format (audio, video and graphic images)	It is a tool of self-evaluation, critical vision formation in the students about their own research; the evaluation portfolio/dossier is used to appreciate the level of competence development aiming at the finality. The materials differ in the content but allow appreciation of the process and the result of the studies. The appreciation will imply content evaluation, implementation correctness, accuracy, value of the information presented, and truthfulness of the reference sources.	During the semester

X. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

- ***Teaching and learning methods used***

Facultative discipline Free radicals and antioxidant systems in pharmacy is taught in the classical way: lectures and seminars. Lectures are read by the lecturer via multimedia in the classroom or online, using different teaching materials and methods: PowerPoint, diagrams, pictures of medicinal plants, plant products, extractive products, chemical formulas of compounds with antioxidant properties; schemes of methods for determining antioxidant action (DPPH; ABTS; FRAP; etc.), schemes and chemical reactions of generation of free radicals in the human body. In the seminars the teachers combine different teaching methods: discussions, interactive discussion, mini-conferences, individual discussions, problem situations,presenting vegetable products, drawings and images of the toxic plants and chemical substances responsible for the toxic effect, action mechanism etc.

- ***Applied teaching strategies / technologies*** *(specific to the discipline)*

- ✓ Interactive strategies for acquiring new knowledge. Mutual learning method, student involvement in group activities, participation of the teacher as a mediator of events or as a co-participant in the construction of knowledge.
- ✓ Interactive strategies for practising and applying new information. They involve activities based on cooperation or competition in order to train and develop skills, abilities and skills to apply what has been learned.
- ✓ Interactive assessment strategies. They involve involving students in the process of their own assessment, stimulating personal reflection on the learning activity, becoming aware of errors and ways of eliminating shortcomings, with the primary aim of improving and adjusting the process, resulting in improved results and stimulating learning, but not sanctioning.

- ***Methods of assessment*** *(including the method of final mark calculation)*

Current:

In the subject Free Radicals and Antioxidant Systems in Pharmacy, during the semester of study, are planned:

1- summations that include the assessment of theoretical knowledge, with the combination of different procedures, which provide for written work on topics or oral discussion.

1- individual work (PowerPoint communication, portfolio presentation).

The annual average is made up of the sum of the marks for the total and individual work divided by 2.

Final: Exam at the end of semester I .

The final grade is made up of the annual average grade (coefficient 0.5) and the grade of the exam (oral or written on subjects), coefficient 0.5. Students with an annual average of less than 5 and students who have not made up their absences from seminars are not admitted to the examination (with a mark).

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-8,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all stages of final examination (computer assisted, test, oral) - are expressed in numbers according to the mark scale (according to the table), and the final mark obtained is expressed in number with two decimals, which is transferred to student's record-book.

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations.

XI. RECOMMENDED LITERATURE:

A. Compulsory

1. Ciobanu N., Cojocaru-Toma M., Pompuș I., Chiru T., Ciobanu C., Benea A. Plante din colecția Centrului Științific de Cultivare a Plantelor Medicinale USMF "Nicolae Testemițanu", Chișinău, Print Caro, 2019, 214 p. ISBN 978-9975-56-660-5.
2. Maria Cojocaru-Toma. Produse vegetale și fitopreparate din Republica Moldova. Chișinău, CEP Medicina, 2017, 330 p. ISBN 978-9975- 82-059-2.
3. Gonciar V., Obrijanu D., Nistreanu A. Elemente de fitofarmacologie.Ch.: 2012, Tipografia Centrală, 248 p. ISBN 978-9975-53-075-0.
4. Меньщикова Е.Б., Ланкин В.З., Зенков Н.К., Бондарь И.А., Круговых Н.Ф., Труфакин В.А. Окислительный стресс. Прооксиданты и антиоксиданты. Москва, М.: Слово, 2006.
5. Бакумов П.А., Островский О.В., Уваров С.Б.Современные антиоксиданты в медицине. Волгоград: ИПК «Царицын», 2001.

B. Additional

1. Gonciar V., Nechifor M., Cheptea E., Scutari C. Farmacologie, Chișinău, Tipografia AȘM, 2015, 580 p. ISBN 978-9975-62-386-5.
2. Pohl F., Lin, P. The potential use of plant natural products and plant extracts with antioxidant properties for the prevention/treatment of neurodegenerative diseases: In vitro, in vivo and clinical trials. Molecules 2018, 23, 3283.
3. Handbook of Antioxidants for Food Preservation. Editor: F Shahidi. 514 p. eBook ISBN: 9781782420972. Disponibil: https://www.elsevier.com/books/handbook-of-antioxidants-for-food-preservation/shahidi/978-1-78242-089-7.
4. Шарова Е.И. Антиоксиданты растений: учеб. пособие. - СПб.: Изд-во С.-Петерб. ун-та. 2016. -140 с. ISBN 978-5-288-05641-3.