

GEOLOGY APPLIED TO THE PHARMACY (GEOPHARMACY): Biocrystallography and Mineral Raw Materials

MODULE	CONTENT	YEAR	TERM	CREDITS	TYPE
Pharmacy	Geopharmacy	2º	2º	6	Optional
PROFESSOR(S)			POSTAL ADDRESS, TELEPHON Nº, E-MAIL		
<ul style="list-style-type: none"> Rafael Delgado Calvo Flores Jesús Párraga Martínez Gabriel Delgado Calvo-Flores Juan Manuel Martín García 			Department of Pedology and Agricultural Chemistry First floor, School of Pharmacy Office 183, 184, 185 y 186. E-mail: rdelgado@ugr.es , jparraga@ugr.es , gdelgado@ugr.es , jmmartingarcia@ugr.es		
			TUTORSHIPS HOURS <u>Rafael Delgado</u> : tuesday de 11,30 a 13,30 (School of Sciences), wednesday and thursday from 11,30 to 13,30 (School of Pharmacy). <u>Jesús Párraga</u> : Monday from 16,00 to 19,00 (School of Sciences) and Tuesday from 9,00 to 12,00 (School of Pharmacy). <u>Gabriel Delgado</u> : monday, Wednesday and friday, from 12,30 to 14,30 (School of Pharmacy). <u>Juan Manuel Martín García</u> : Monday from 12,00 to 14,00 (School of Sciences) and Tuesday and Wednesday from 12,00 to 14,00 (School of Pharmacy).		
DEGREE IN WHICH THE SUBJECT IS TAUGHT			OTHER DEGREES THAT COULD TEACH THE SUBJECT		
Pharmacy			Environmental Sciences, Chemical Sciences, Biochemistry, Medicine and Life Sciences		
PREREQUISITES and/or RECOMENDATIONS (if applicable)					
Appropriate knowledge of Mathematics, Physics, Chemistry, Physical Chemistry. Some basic knowledge of the Natural Environment.					
BRIEF DESCRIPTION OF CONTENT (ACCORDING TO THE DEGREE)					
Biocrystallography. Principles of crystallography Applied to the Pharmacy: polymorphism. Excipients, active ingredients and toxic minerals: raw materials for application in Pharmacy, Cosmetics and other Health Sciences. Human Biominerals (bones, teeth, calculus).					
GENERAL AND SPECIFIC ABILITIES					



General abilities: CG1, CG4, CG12 y CG15.

Specific abilities: CEM1.1, CEM1.2, CEM1.3, CEM1.5, CEM1.9, CEM1.10, CEM1.11, CEM3.1, CEM4.2, CEM4.5, CEM5.14, CEM5.15, CEM6.1, CEM6.4, CEM6.6, CEM6.7.

OBJECTIVES (EXPRESSED AS EXPECTED RESULTS OF THE TEACHING)

- 1 Biocrystallography: Crystallography of biological macromolecules. Crystallization: methods for studying.
- 2.-Polymorphism: influence of the crystal structure and the physical, chemical and physico-chemical properties in the bioavailability of substances (crystalline/minerals) used in pharmaceutical formulations.
- 3 Mineral raw materials of interest in Pharmacy and Cosmetics: active ingredients, excipients and toxic. Pharmacopoeia standards for use.
4. Human Biominerals: not pathological (bones, teeth, etc) and pathological (calculus)

TOPICS OF THE SUBJECT

THEORETICAL PROGRAM

BLOCK 1.- Concept. Fundamentals of Biocrystallography.

Theme 1.- Concept of the subject

1.1. The concept of Geopharmacy. 1.2 Fields of study: Biocrystallography, Pharmaceutical Polymorphism, Mineral Raw Materials, Biominerals. 1.3 Scientific-historic framework. 1.4 Hundred and sixty years of Geopharmacy in the School of Pharmacy of the University of Granada.

Theme 2.- Fundamentals of Biocrystallography

2.1 Introduction. 2.2. The Biocrystallography as a tool in the Health Sciences. 2.2 Physical state and state of order. 2.3. Crystalline and amorphous States. 2.4 Condensate systems: crystals, polymers, liquid crystals and amorphous. 2.4 Crystals and crystalline lattices. 2.5 Crystalline defects. 2.6. Symmetry. 2.7 Use of symmetry in Health Sciences

BLOCK 2.- Crystallization, properties, and methods of study specific for crystalline solids

Theme 3. - Basic principles of crystallization

3.1 Formation of crystalline solids. 3.2 Nucleation. 3.3 Growth. 3.4. Scientific and technological applications. Case of biological macromolecules.

Theme 4.- Pharmaceutical and cosmetic properties of crystalline solids

4.1 Concept and classification. 4.2 Physical properties. 4.3 Chemical properties. 4.4. Physico-chemical properties. 4.5. Main applications to the Health Sciences.

Theme 5.- Pharmaceutical polymorphism

5.1. The concept of Crystalchemistry. 5.2 Types of structures. 5.3. Pharmaceutical polymorphism, how influences on the bioavailability of active principles, excipients and pharmaceutical technology. 5.4. Other morphotropics phenomena of interest in the Health Sciences

Theme 6.- Specific methods of study for crystalline solids

6.1 Introduction. 6.2. Main methods based on interactions with electromagnetic radiation. 6.3 Methods related with electron microscopy. 6.4. Other advanced methods.

BLOCK 3.- Crystallography of biological macromolecules

Theme 7.- History of the Crystallography of Biological Macromolecules

7.1 First studied macromolecular structures. 7.2. Nobel Prizes and macromolecular crystals. 7.3. The crystallography of biological macromolecules and the current progress of Science: Molecular Biology and genomics. Organic



macromolecules

Theme 8.- Crystallization of macromolecules

8.1 Background. 8.2. Schema of study of macromolecular crystals. 8.3. Crystallization of macromolecules. 8.4. Factors that influence.

Theme 9 .- Structure of macromolecular crystals

9.1 The structure determination process. 9.2. Main methods. 9.3. Examples of macromolecular crystals: DNA, proteins, viruses, organic molecules, drugs, etc.

BLOCK 4. Mineral raw materials for pharmaceutical and cosmetic use. Toxic minerals.

Theme 10.- Mineral classification applied to Pharmacy and Cosmetics

10.1 Principles of mineral classification. 10.2 Classes of minerals. 10.3 Species not silicate of interest in Pharmacy and Cosmetics. Oxides, hydroxides, carbonates, sulphates and other minerals.

Theme 11.- Silicates of interest in Pharmacy and Cosmetics I

11.1. Structural classification of silicates. 11.2. Criteria for classification into subclasses. 11.3 Tectosilicates. 11.4 Group of silica: quartz, opal. glass (his aptitude in pharmacopoeia). 10.5 The zeolite group.

Theme 12.- Silicates of interest in Pharmacy and Cosmetics II

12.1. Fillosilicates. 12.2. Structural classification of fillosilicates. 12.3. kaolinite, talc and smectites (bentonites). Pharmaceutical and cosmetic uses. 12.4. Other fillosilicates.

Theme 13.- Carcinogenic fiber in Pharmacy. Other toxic minerals

13.1 Background. 13.2. Concept of fiber. 13.3 Fibrous inosilicates. 13.4 Fibrous phyllosilicates. 13.5. Assumptions about mechanisms of induction of carcinogenesis by mineral fibres. 13.6. International regulations. 13.7. Other toxic minerals.

BLOQUE 5.- Aptitude in Pharmacy of mineral materials

Theme 14.- Minerals as active principles

14.1. Introduction to the therapeutic activity of minerals. 14.2. The clay in pharmaceutical formulations. New trends. 14.3 Minerals aptitude tests.

Theme 15.- Minerals as excipients. Cosmetic uses

15.1. Minerals as excipients. 15.2. An overview of the interaction between drugs and mineral excipients. Monographs of bentonite. 15.3. The aptitude tests for mineral excipients. 15.4 Mineral cosmetics.

BLOQUE 6.- Human biominerals. Relations of minerals with life. Minerals, environment and human health

Theme 16.- Main human phosphate biominerals

16.1. Concept of biomineralization. 16.2 Human biominerals. 16.3 Biominerals of the bone. 16.4 Biominerals of the tooth.

Theme 17.- Other human biominerals

17.1. The biominerals of the otoliths. 17.2 Lithiasis. 17.3 Other human biominerals.

Theme 18.- Mineral origin of life

18.1 History. 18.2. The biological world as a result of the mineral world. 18.3. Replication of biomolecules in mineral templates. 18.4 Hypotheses about the mineral origin of life. 18.5. The alkaline world: geomembranes and geoenzymas.

Theme 19.- Minerals, environment and human health (Geomedicine)

19.1 Concept and interest of the Geomedicine. 10.2. Toxic and essential elements for life. 19.3. Cycles of these elements in nature. Role of minerals. 19.4 Human health in relation to alterations of the cycles of the elements: deficiencies, excesses, imbalances and optimal. 19.5. The soil as a medium organomineral and “backbone” of terrestrial ecosystems; importance to human health. 19.6 Minerals in the air: origin and effects "per se" and as carriers of biological materials. Importance to human health.



PRACTICAL PROGRAM

Practice 1

Controlled formation of crystals. Crystallization of substances with inorganic nature. Crystallisation techniques for substances for pharmaceutical use (polymorphism). Formation of macromolecular crystals of protein. Precipitation of pharmaceutical cocrystals. Recrystallization of active pharmaceutical ingredients.

Practice 2

Formation of "Crystal Gardens": an experiment about the mineral origin of life.

Practice 3

Assays of Pharmacopoeia for minerals of pharmaceutical and cosmetic uses.

Practice 4

Recognition and quantification of mineral species and other crystalline substances of pharmaceutical and cosmetic uses using X-ray diffraction techniques. Internal structure of crystalline material. Study of the crystal lattice and symmetry.

Practice 5

Recognition and analysis of mineral species and other crystalline substances of pharmaceutical and cosmetic uses using scanning electronic microscopy techniques.

PROGRAM OF SEMINARS. ORAL EXPOSITION OF PAPERS

Seminar 1

Search for knowledge: books, journals, reports; computer search. Processing of the information. Drafting of a bibliographic paper.

Seminar 2

Oral exposition of paper. Scientific criticism and debate.

BIBLIOGRAPHY

BASIC BIBLIOGRAPHY:

Fundamentals of Crystallography

Authors: C. Giacovazzo, H.L. Monaco, D. Viterbo: F. Scordari G.Gilli. G.Zanotti. M. Catti.

Year of publication: 2002

Editorial: Oxford Science Publications

Crystal Growth. Principles and Progress

Authors: A. W. Vere

Year of publication: 1998

Editorial: Plenum Press

Métodos de Difracción de Rayos-X. Principios y Aplicaciones

Authors: Joaquín Bermúdez Polonio

Year of publication: 1981

Editorial: Pirámide

Manual de Mineralogía de DANA

Authors: Comelius. S. Hulburt Jr. : Cornelis Klein

Year of publication: 2003

Editorial: Reverte, S.A.

Mineralogy for Students

Authors: M. H. Battey

Year of publication: 1997

Editorial: Longman Scientific & Technical



Mineralogie des Argiles. 1, Structure et Propriétés Physico-chimiques

Authors: S. Caillière S. Hénin M. Rautureau
Year of publication: 1997
Editorial: INRA Actualités Scientifiques et Agronomiques

Modern Crystallography. I. Symmetry of Crystals, Methods of Structural Crystallography

Authors: B.K. Vainshtein
Year of publication: 1994
Editorial: Springer Verlag.

Modern Crystallography II. Structure of Crystals

Authors: S.K. Vainshtein: V.M. Fridkin: V.L. Indenbomm
Year of publication: 2000
Editorial: Springer Verlag.

An introduction to the rock forming minerals

Authors: W.A. Deer, R.A. Howie, J. Zussman
Year of publication: 1992
Editorial: Longman Scientific & Technical

Mineralogía Aplicada. Salud y Medio Ambiente

Authors: M.I. Carretero, M. Pozo
Año de publicación: 2007
Editorial: Thomson

Geomedicine

Authors: Låg J
Year of publication: 1990
Editorial: CRC Press, USA.

Medical Mineralogy and Geochemistry.

Authors: Nita S, Schoonen MAA (Eds.)
Year of publication: 2006
Editorial: Reviews in Mineralogy and Geochemistry Volume 64. Geochemical Society and Mineralogical Society, USA

Essentials of Medical Geology

Authors: Sellinus O, Alloway B, Centeno JA, Finkelman RB, Fuge R, Lindh U, Smedley P
Year of publication: 2007
Editorial: Elsevier Academic Press.

Medical Geology : Effects of Geological Environments on Human Health

Authors: Komatina MM
Year of publication: 2004
Editorial: Developments in Earth and Environmental Sciences, 2. Elsevier

SUPPLEMENTARY BIBLIOGRAPHY:

- Abrahams PW (2002). Soils: their implications to human health. *The Science of Total Environment*, 291:1-32.
- Abrahams PW (2006). Soil, geography and human disease: a critical review of the importance of medical cartography. *Progress in Physical Geography*, 30: 490-512.
- Bunnell JE, Finkelman RB, Centeno JA, Selinus O (2007). Medical Geology: a globally emerging discipline. *Geologica Acta*, 5: 273-281.
- Delgado, R., Delgado, G., Ruiz, A., Gallardo, V., Gámiz, E. 1994. The crystallinity of several Spanish kaolins: correlations with sodium amylobarbitone release. *Clay Miner.* 29, 785 – 797.
- Gámiz, E., Caballero, E., Delgado, M., Delgado, R., 1988 a. Characterization of Spanish kaolins for pharmaceutical use. I. Chemical and mineralogical composition, physico-chemical properties. *Bolletino Chim. Farm.* 127(5), 114-120.



- Gamiz, E., Delgado, G., Delgado, R., 1988 b. Characterization of Spanish kaolins for pharmaceutical use. II. Assays according British Pharmacopoeia. *Bolletino Chim. Farm.* 127(6), 138 – 143.
- Hiramatsu, Y., Suzuki, H., Kuchiki, A., Nakagawa, H., Fuji, S. 1996. X – ray structural studies of Lomeridine Dihydrochloride polymorphs. *J. Pharm. Sci.* 85, 761- 766
- Låg J (1994). Geomedicine, an expanded application of soil science. 15th World Congress of Soil Science (Acapulco, Mexico), vol 3A: 557-567.
- Oliver MA (1997). Soil and human health: a review. *European Journal of Soil Science*, 48: 573-592.
- Skinner HCW (2007). The earth, source of health and hazards: an introduction to medical geology. *Annual Review of Earth and Planetary Sciences*, 35: 177-213.
- Steinness E (2009). Soils and geomedicine. *Environmental Geochemistry Health*, 31: 523-535.
- Soriano, M., Melgosa, M., Sánchez-Marañón, M., Delgado, G., Gámiz, E., Delgado, R. 1998. Whiteness of talcum powders as a quality index for pharmaceutical uses. *Color Res. Appl.* 15, 261-265.
- Soriano, M., Sánchez-Marañón, M., Melgosa, M., Gámiz, E., Delgado, R. 2002. Influence of chemical and mineralogical composition on color for commercial talcs. *Color Res. Appl.* 27, 430-440.

RECOMMENDED LINKS

- Geology 114 Lecture Notes: <http://www.geol.ucsb.edu/faculty/hacker/geol114A/lectureNotes.htm>
- The Crystal Structure of Proteins: http://images.google.es/imgres?imgurl=http://supfam.mrc-lmb.cam.ac.uk/elevy/perso/images/image_02.png&imgrefurl=http://supfam.mrc-lmb.cam.ac.uk/elevy/perso/elevyArt.html&usg=__clp9IMH6nondroQINBJDhr4Tvko=&h=618&w=680&sz=369&hl=es&start=37&tbid=sXsYFe2WWQwc9M:&tbnh=126&tbnw=139&prev=/images%3Fq%3Dcrystal%2Bsimmetry%2B.gif%2Banimation%26gbv%3D2%26ndsp%3D18%26hl%3Des%26sa%3DN%26start%3D36
- Mineralogy Database: <http://webmineral.com/>
- Common Minerals and Their Uses: <http://www.mii.org/commonminerals.php>
- Some Fundamentals of Mineralogy and Geochemistry:
http://images.google.es/imgres?imgurl=http://www.gly.uga.edu/railsback/Fundamentals/PhyllosilicatesI%26II06IILS.jpg&imgrefurl=http://www.gly.uga.edu/railsback/FundamentalsIndex.html&usg=__KjShsJ758jq9mJP5M_v3B1BqKGA=&h=1105&w=1430&sz=314&hl=es&start=5&tbid=Amj0eyV41UgHIM:&tbnh=116&tbnw=150&prev=/images%3Fq%3Dphyllsilicate%2Bcontents%26gbv%3D2%26hl%3Des
- Twinning, Polymorphism, Polytypism, Pseudomorphism: <http://www.tulane.edu/~sanelson/eens211/twinning.htm>

TEACHING METHODOLOGY

- Theoretical academic sessions**, this teaching technique is based on the lectures. Approximate duration of one hour; in it the teacher will explain the theoretical foundations of the subject. It will stimulate the active participation of the student.
- Practical academic sessions**. They will be in the laboratory of crystallography, mineralogy and radiocristalography. The number of students is 25 and the teacher will direct the work of each individual. The day-to-day of each student will be valued even if at the end a test, oral and written, will be made to estimate the degree of learning of these practical sessions.
- Seminars, oral exposition of papers and debate**.
 In these sessions will discuss and clarify issues related to the theoretical sessions. Also, some of these sessions will be used for the oral presentation of the students of academic activities directed by the teacher. These sessions will be accompanied by a debate.



PROGRAMME OF ACTIVITIES

First semester	Themes	Class activities					Self-study				
		Theoretic al sessions (hours)	Practical sessions (hours)	Seminars and oral exposition of papers (hours)	Exams (hours)	Etc.	Individual tutoring (hours)	Colective tutoring (hours)	Individual study of students (hours)	Teamwor k (hours)	Etc.
Week 1	1, 2	2		1				4			
Week 2	3	2	1					4			
Week 3	4	2	1	1				4			
Week 4	5	1,5	1	1	0,5			5			
Week 5	6	1	1	2				4			
Week 6	7, 8	2	1	1				4			
Week 7	9, 10	3	1					4			
Week 8	11	2	1	1	0,5			5			
Week 9	12	1	1	2				4	2		
Week 10	13	2	1	1				4	2		
Week 11	14	1	1	2				4	2		
Week 12	15	1	1	2	0,5			5	2		
Week 13	16	2	1	1				4	2		
Week 14	17	2	1	1				4	2		
Week 15	18	2.5	1		0,5			5	2		
Week 16	19	1		2	2			5	3		
Total	19	28	14	18	4			69	17		



EVALUATION (EVALUATION INSTRUMENTS, EVALUATION CRITERIA AND PERCENTAGE ON THE FINAL QUALIFICATION, ETC.)

- 1.- Exam written about the contents of the program. It may be test type, questions of application of theoretical concepts or problems.
- 2.- Exam of practices and seminars: oral and written. Seek to be scrutiny which apply the theoretical and practical knowledge through problem solving.
- 3.- Realization and presentation of a collective paper on specific aspects of the subject.
- 4.- Assistance to academic activities organised and accepted by the Faculty of Pharmacy or the University of Granada, related with the subject.

The approved practices and seminars is *sine qua non* for the overcoming of the subject

To overcome any exams of the subject, it is necessary to get a score higher than the average between the null value and the highest possible rating. Scores below average, but close to it, such will be evaluated taking into account all the work done during the course.

The theoretical-practical sessions and seminars are mandatory. Assistance to the theoretical activities will be assessed positively.

Exposure of the collective paper will be assessed based on the level of knowledge, clarity in the exposition and defence of the knowledge exposed.

The assistance to other academic activities, whose theme is related to the subject, will be valued if the student presents a summary of the exposed in such activity and officially justified its assistance.

ADDITIONAL INFORMATION

Not necessary

