

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

MODULE	CONTENT	YEAR	TERM	CREDITS	TYPE
Pharmacy	Geopharmacy	2º, 3º, 4º	1º	6	Optional
LECTURER(S)			POSTAL ADDRESS, TELEPHON Nº, E-MAIL		
<ul style="list-style-type: none"> <li>Rafael Delgado Calvo Flores</li> <li>Jesús Párraga Martínez</li> <li>Gabriel Delgado Calvo-Flores</li> <li>Juan Manuel Martín García</li> </ul>			Department of Pedology and Agricultural Chemistry First floor, School of Pharmacy Office 183, 184, 185 y 186. E-mail: <a href="mailto:rdelgado@ugr.es">rdelgado@ugr.es</a> , <a href="mailto:jparraga@ugr.es">jparraga@ugr.es</a> , <a href="mailto:gdelgado@ugr.es">gdelgado@ugr.es</a> , <a href="mailto:jmmartingarcia@ugr.es">jmmartingarcia@ugr.es</a>		
			TUTORSHIPS HOURS		
			R. Delgado: Tuesday, Thursday 11,30 to 13,30 and Friday from 10,30, to 12.30 (F. Pharmacy) J. Parraga: Tuesday and Thursday from 11,30 to 13,30; Wednesday from 10.30 to 12.30 (F. Pharmacy) G. Delgado: Monday, Wednesday and Friday from 10.30 to 12.30 (F. Pharmacy) J. M. Martin: Monday, Tuesday from 11,30 to 13,30 and Friday from 10,30 to 12,30 (F. Pharmacy)		
DEGREE WITHIN 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**

**PART 1.- Concept. Fundamentals of Biocrystallography.**

Theme 1.- Concept of the subject

Theme 2.- Fundamentals of Biocrystallography

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

Theme 3. - Basic principles of crystallization

Theme 4.- Pharmaceutical and cosmetic properties of crystalline solids

Theme 5.- Pharmaceutical polymorphism

Theme 6.- Specific methods of study for crystalline solids

**PART 3.- Crystallography of biological macromolecules**

Theme 7.- History of the Crystallography of Biological Macromolecules

Theme 8.- Crystallization of macromolecules

Theme 9.- Structure of macromolecular crystals

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

Theme 10.- Mineral classification applied to Pharmacy and Cosmetics. Species not silicate of interest in Pharmacy and

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

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

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



## **PART 5.- Aptitude in Pharmacy of mineral materials**

Theme 14.- Minerals as active principles

Theme 15.- Minerals as excipients. Cosmetic uses

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

Theme 16.- Main human phosphate biominerals

Theme 17.- Other human biominerals

Theme 18.- Mineral origin of life

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

## **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/geo114A/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&usq=\\_\\_clp9lMH6nondroQINBJDhr4Tvko=&h=618&w=680&sz=369&hl=es&start=37&tbnid=sXsYFe2WWQwc9M:&tbnh=126&tbnw=139&prev=/images%3Fq%3Dcrystal%2Bsimmetry%2B.gif%2Banimation%26gbv%3D2%26ndsp%3D18%26hl%3Des%26sa%3DN%26start%3D36](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&usq=__clp9lMH6nondroQINBJDhr4Tvko=&h=618&w=680&sz=369&hl=es&start=37&tbnid=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&usq=\\_\\_KjShsJ758jq9mJP5M\\_v3B1BqKGA=&h=11](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&usq=__KjShsJ758jq9mJP5M_v3B1BqKGA=&h=11)



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-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				
		Theoretical 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)	Teamwork (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.

#### THE ONLY FINAL EVALUATION

According to the Regulation of Evaluation and of Qualification of the Students of the University of Granada (Approved by Advice of Government in his extraordinary session of May 20, 2013), contemplates the accomplishment of the only final evaluation in which there will be able to take refuge those students who could not expire with the method of continuous assessment for labor motives, bill of health, disability or any other due well-taken reason that prevents them from following the regime of continuous assessment. To take refuge in the only final evaluation, the student, in the first two weeks of after registering of the subject, it will request it the Director of the Department who will give movement to the corresponding professorship, invoking and accrediting the reasons that they attend him.

#### ADDITIONAL INFORMATION

Not necessary

