

## 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>Gabriel Delgado Calvo Flores</li> <li>Jesús Párraga Martínez</li> <li>María Virginia Fernández González</li> <li>Juan Manuel Martín García</li> <li>Márquez Crespo, Rocío</li> <li>Alberto Molinero García</li> </ul>			Dpto. Edafología y química Agrícola, 1ª planta, Facultad de Farmacia. Despachos nº 182, 184, 185, 186 y CIC (Farmacia). Correo electrónico: <a href="mailto:jparraga@ugr.es">jparraga@ugr.es</a> , <a href="mailto:gdelgado@ugr.es">gdelgado@ugr.es</a> , <a href="mailto:mvirginiafernandez@ugr.es">mvirginiafernandez@ugr.es</a> , <a href="mailto:jmmartingarcia@ugr.es">jmmartingarcia@ugr.es</a> , <a href="mailto:semfarma@ugr.es">semfarma@ugr.es</a> , <a href="mailto:amgar@correo.ugr.es">amgar@correo.ugr.es</a>		
			TUTORSHIPS HOURS		
			<a href="http://www.ugr.es/local/edafolo/">http://www.ugr.es/local/edafolo/</a>		
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 Biomaterials (bones, teeth, calculus). Principles of Biomedicine: environments-mineral-human health					
GENERAL AND SPECIFIC ABILITIES					
<p><b>General abilities:</b> CG1, CG4, CG12 y CG15.</p> <p><b>Specific abilities:</b> 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.</p>					
OBJECTIVES (EXPRESSED AS EXPECTED RESULTS OF THE TEACHING)					
<p>1 Biocrystallography: Crystallography of biological macromolecules. Crystallization: methods for studying.</p> <p>2.-Polymorphism: influence of the crystal structure and the physical, chemical and physico-chemical properties in the</p>					



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)  
5. Some concepts about Geomedicine: the relationships between soils and human health

#### TOPICS OF THE SUBJECT

- Topic 1.- Concept of the subject
- Topic 2.- Fundamentals of Bio-crystallography
- Topic 3.- Basic crystallization principles
- Topic 4.- Properties of crystalline solids, of pharmaceutical and cosmetic interest
- Topic 5.- Pharmaceutical polymorphism
- Topic 6.- Specific study methods of crystalline solids
- Topic 7.- Crystallography of biological macromolecules
- Topic 8.- Principles of Pharmaceutical Mineralogy. Mineral systematics applied to Pharmacy and Cosmetics
- Topic 9.- Pharmaceutical use of Minerals: Active principles, Excipients
- Topic 10.- Minerals used in therapeutic and aesthetic centers
- Topic 11.- Minerals in Pharmacopoeias
- Topic 12.- Minerals harmful to human health and the environment
- Topic 13.- Biominerals
- Topic 14.- Notions of Geomedicine: Soils as a natural mineral medium and its influence on 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. Giacobozzo, 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-](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=\_\_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&usg=\\_\\_KjShsJ758jq9mJP5M\\_v3B1BqKGA=&h=1105&w=1430&sz=314&hl=es&start=5&tbnid=Amj0eyV41UgHIM:&tbnh=116&tbnw=150&prev=/images%3Fq%3Dphyllosilicate%2Bcontents%26gbv%3D2%26hl%3Des](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&tbnid=Amj0eyV41UgHIM:&tbnh=116&tbnw=150&prev=/images%3Fq%3Dphyllosilicate%2Bcontents%26gbv%3D2%26hl%3Des)

-Twinning, Polymorphism, Polytypism, Pseudomorphism: <http://www.tulane.edu/~sanelson/eens211/twinning.htm>

