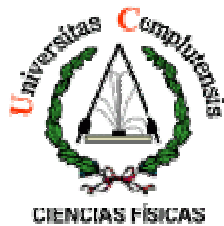


Official Postgraduate Programs



Master in Biomedical Physics
Faculty of Physics
Universidad Complutense de Madrid

Short English version

Master in Biomedical Physics

Layout

Common Main Formation		
Physics for Biomedical Sciences (18 ECTS)	Biomedicine (12 ECTS)	Research or Professional Work (24 ECTS)
Physics Complements (6 c)	Elements of Anatomy and Physiology (6 c)	
Biophysics (6 c)	Elements of Biology (6 c)	
Radiophysics (6 c)		
3 BRANCHES (60 ECTS)		
Biomedical Instrumentation	Biophysics	Radiophysics
Basic Blocks (18 ECTS)		
Biomedical Instrumentation Principles	Thermodynamics of Biological Systems (6 c)	Physical Basis of Radiotherapy (6 c)
Medical Imaging (6 c)	Methodology and Biochemical Experimentation (6 c)	Techniques in Radiodiagnostics (6 c)
Non-ionizing radiations (6 c)		Radiological Protection and Dosimetry (6 c)
Laboratory of Bioelectromagnetism (6 c)	Biomembranes Structure and Dynamics (6 c)	
Complements		
Bioenergetics (3 c)	Nuclear Magnetic Resonance (6 c)	
Physics of Biomembranes (6 c)	Ultrasounds in Medicine (6 c)	
Physics of Vision (3 c)	Laser in Medicine (6 c)	

Code:	121	Subject:	Physics Complements	
Speciality/module			ECTS credits	Type
Physics in Biomedical Sciences			6	Compulsory Subject
Lectures hours			Practical hours	Personal work
38			7	120
Contents				
Vector operators. Foundations and principles of the thermodynamics, heat transmission, dissolutions and mixtures, the alive being like thermodynamic system. Electrostatics and magnetostatics, Maxwell equations, wave equations, polarization. Reflection and refraction, phenomena of interference and diffraction. Matter structure, quantum atom model, atomic transitions. Atomic nucleus properties, disintegrations. Electrical circuits practices, electrical measures and instrumentation. Practices in numerical calculation, programming and computers.				
Bibliography				
- <i>Física</i> , M. Alonso, E.J. Finn, Ed. Pearson Education, 2000				

Code:	122	Subject:	Biophysics	
Speciality/module			ECTS credits	Type
Physics in Biomedical Sciences			6	Compulsory Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Molecular interactions. Molecular recognition. Cooperativity. Order-disorder transitions. Biopolymer statistics. Motility. Muscle contraction. Prebiotic evolution and the origin of life. Autoorganization, molecular selection end evolution.				
Bibliography				
<i>Biophysics</i> . R, Glaser. Springer.1999.				
<i>Biophysics. An Introduction</i> . R. Cotterill. Wiley. 2003.				
<i>Biophysics</i> . W. Hoppe y otros (Eds.). De. Springer-Verlag. 1983.				
<i>Biological Physics. Energy, Information and Life</i> . P. Nelson. Freeman and Co. 2004				

Code:	123	Subject:	Radiophysics	
Speciality/module			ECTS credits	Type
Physics in Biomedical Sciences			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Charged particles interactions with matter. Photons interactions with matter. Interaction between neutrons. Ionised radiation generation. Ionised radiation detectors.				
Bibliography				
G.F. Knoll: <i>Radiation detection and measurement</i> , . Wiley (2000) H.E. Johns and J.R. Cunningham: <i>The physics of radiology</i> , Charles C Thomas (1983) F.H. Attix: <i>Introduction to radiological physics and radiation dosimetry</i> . Wiley (1986)				

Code:	124	Subject:	Elements of Anatomy and Physiology	
Speciality/module			ECTS credits	Type
Biomedicine			6	Compulsory Subject
Lectures hours			Practical hours	Personal work
26			19	100
Contents				
Nervous system. Brain and spinal marrow. Thermoregulation. The skeletal and muscular system. Endocrine system. Reproductive system. Cardiovascular system. Renal system. Gastrointestinal system. Respiratory system.				
Bibliography				
Gerald J. Tortora & Bryan Derrickson. Principles of Anatomy and Physiology. Eleventh edition. 2006 by Biological Sciences Textbooks, Inc. and Bryan Derrickson. Published by John Wiley& Sons, Inc.				
Gillian Pocock & Christopher D. Richards. Human Physiology. The basis of Medicine. Second edition. Oxford University Press. 2004				

Code:	125	Subject:	Elements of Biology	
Speciality/module			ECTS credits	Type
Biophysics			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Structure and function of biological molecules. Biological systems. Basic cell structure and functions. Membrane physiological activities. Metabolic routes. Energy mechanism production. Regulation mechanisms. Biogeochemistry cycles. Cellular evolution processes. Molecular and classical genetics notions.				
Bibliography				
• <i>Biología Celular y Molecular</i>, Lodish, H. et al. Ed Panamericana (2005) • <i>Introducción a la Biología Celular</i>, Alberts B. et al Ed Médica Panamericana (2005) • <i>Bioquímica</i>, Lehninger, A.L., Ed Omega • <i>Biología</i>, Solomon, E.P. Ed McGraw-Hill (2002) • <i>Bioquímica</i>, Strayer L. Ed Reverté (2003)				

Code:	126	Subject:	Thermodynamics of Biological Systems	
Speciality/module		ECTS credits		Type
Biophysics		6		Optional Subject
Lectures hours		Practical hours		Personal work
30		15		105
Contents				
General introduction to the irreversible processes. Reversibility and irreversibility. Far of equilibrium thermodynamics. Breathing biophysics. Gas diffusion. Breathing dynamics. Transport phenomena in biological systems .				
Bibliography				
• <i>Introducción a la termodinámica de los procesos irreversibles</i>, I. Prigogine, Selecciones Científicas (1974) • <i>Non-equilibrium thermodynamics</i>, S.R. de Groot and P. Mazur, Dover Publications (1984) • <i>Biofísica: Procesos de autoorganización en Biología</i>, F. Montero y F. Morán, Eudema Universidad (1992) • <i>Biophysics</i>, R. Glaser, Springer (2001)				

Code:	127	Subject:	Methodology and Biochemical Experimentation	
Speciality/module			ECTS credits	Type
Biophysics			6	Optional Subject
Lectures hours			Practical hours	Personal work
23			23	90
Contents				
UV-visible absorption spectroscopy. Proteins spectrophotometry. Emission fluorescence. Ultracentrifugation. Electrophoresis. Chromatography.				
Bibliography				
García-Segura, J.M., Gavilanes, J.G., Martínez, A., Montero, F., Oñaederra, M. & Vivanco, F. (1996) "Técnicas instrumentales de análisis en Bioquímica". Editorial Síntesis, Madrid. Boyer, R.F. (2000) "Modern experimental Biochemistry” (3ª edición). Benjamin/Cummings Publishing Company, Redwood City, California.				

Code:	128	Subject:	Biomembranes Structure and Dynamics	
Speciality/module		ECTS credits		Type
Biophysics		6		Optional Subject
Lectures hours		Practical hours		Personal work
23		23		90
Contents				
Lipid structure. Phase transitions and lipid polymorphism. Experimental models: Monolayer and liposomes. Membrane proteins. Membrane permeabilization and fusion. Membrane lateral structure: domains and rafts.				
Bibliography				
R. Grisshammer, S.K. Buchanan. “Structural biology of membrane proteins”. RSC Publishing, 2006.				
O. G. Mouritsen. “Life – As a matter of fat. The emerging science of lipidomics”. Springer, Berlin, 2005.				
Lukas K. Tamm. “Protein-Lipid interactions: from membrane domains to cellular networks”. John Wiley & sons, 2005.				
D.E. Vance, J.E. Vance. “Biochemistry of lipids, lipoproteins and membranes”, 4 ^a Ed. Elsevier, 2002.				
P.L. Yeagle. “The structure of biological membranes”, 2 ^a Edición. CRC Press, New York, 2005.				

Code:	129	Subject:	Medical Imaging	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Image formation. Linear systems. Image characteristics (resolution, contrast and noise). Digital detectors for x-rays. Image processing. Coherent optical tomography. Volumetric digital holography. 2D and 3D tomographic reconstruction. Multimodal image. Foundations of the statistical image analysis (ROC, AFROC...). Displays. PACS.				
Bibliography				
I. Bankman, Handbook of Medical Imaging: Processing and Analysis (Biomedical Engineering), Academic Press (2000). J. Goodman, Introduction to Fourier Optics, Third Edition, Roberts and Company Publishers (2004). A. Papoulis and S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes, 4 th Ed. McGrawHill (2002). H.H. Barret and W. Swindell, Radiological Imaging: The theory of Image Formation, Detection, and Processing, Academic Press, (1981). J. Beutel, H. Kundel, R.L. Van Metter, Handbook of Medical Imaging (Vols. I, II, III), SPIE Press (2000).				

Code:	130	Subject:	Non-Ionizing Radiations
Speciality/module		ECTS credits	Type
Biomedical Instrumentation		6	Optional Subject
Lectures hours		Practical hours	Personal work
30		15	105
Contents			
Radiation fields. Electromagnetic field transmission and absorption. Interferences. Shielding techniques. Antennas and field probes. Non-ionizing radiation measurements. Biological effects: physical mechanisms and experimental observations. Non-ionizing radiation dosimetry. Requirements and recommendations on electromagnetic field exposure.			
Bibliography			
Basic Introduction to Bioelectromagnetics, Carl H Durney, Douglas A Christensen CRC Press 1999. Biological effects of Electric and Magnetic Fields, Vols.1 and 2. D.O. Carpenter. Academic Press, 1994. Handbook of biological effects of electromagnetic fields. C. Polk and E. Postow. CRC Press. 2 nd . Edn., 1995.			

Code:	131	Subject:	Laboratory of Bioelectromagnetism	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation			6	Optional Subject
Lectures hours			Practical hours	Personal work
15			30	75
Contents				
Biomedical signal detection. Sensors and electrodes. Bioimpedance. Measurement of physiological events. Measurement of bioelectrics events. Magnetoencephalography. Cell manipulation techniques.				
Bibliography				
[1] J.M. Miranda, Notes on Laboratory of Bioelectromagnetism.				
[2] L.A. Geddes, L.E. Baker, “Principles of Biomedical Instrumentation”, 3 rd Ed. Wiley, 1989.				
[3] Bioinstrumentation, Edited by John G. Webster, 2004				
[4] Agilent Application Notes: “Spectrum Analyzer Basics” AN 150, www.agilent.com				
[5] Agilent Application Notes: “Impedance Measurement Handbook”, www.agilent.com				
[6] Tektronix, “XYZ of Oscilloscopes” 1999, www.tektronix.com				
[7] J. M. Miranda, JL Sebastián, M Sierra, J Margineda, Ingeniería de Microondas: Técnicas Experimentales”, Pearson, 2002.				

Code:	132	Subject:	Radiological Protection and Dosimetry	
Speciality/module		ECTS credits		Type
Radiophysics		6		Optional Subject
Lectures hours		Practical hours		Personal work
30		15		105
Contents				
Radiation biological effects. Radiobiology. Radiological safety basis. Principles and control methods. Legislation. Kerma and absorbed dose. The Bragg-Gray cavity. Exposure. Absorbed dose measurement with ionization chambers. Absorbed dose determination by Monte Carlo techniques. Other dosimetric techniques.				
Bibliography				
Radiological protection (International Legislation)				
Bushong, S.C. "Radiologic Science For Technologists," 3rd Ed., Mosby, ST. Louis, 1984. Cember, H. "Introduction to Health Physics," 2nd Ed., Pergamon, New York, 1983. Johns and Cunningham, "The Physics of Radiology". Khan, "The Physics of Radiotherapy". NCRP Report No. 91 and No. 93, NCRP, Bethesda, 1987. Turner, J.E. "Atoms, Radiation, and Radiation Protection," Permagon, New York, 1986.				
Dosimetry:				
Attix, F.H. "Introduction to Radiological Physics and Radiation Dosimetry," Wiley, New York, 1986. Cameron and Skofronik. "Medical Physics" Hendee. "Medical Radiation Physics" Johns and Cunningham. "The Physics of Radiology", Charles C Thomas, 1983				

Code:	133	Subject:	Techniques in Radiodiagnostics	
Speciality/module			ECTS credits	Type
Radiophysics			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
X-ray production and properties. X-ray beam quality (half value layer). Radiographic imaging. Conventional examinations, computerized tomography, mammography, interventionism. Digital X-ray detectors. Image techniques in Nuclear Medicine: gammagraphy, positron emission tomography (PET), single photon emission computed tomography (SPECT). Radiotracers. Physical and biological half-life. Dose reference levels. Assessment of radiographic image quality.				
Bibliography				
P. Suetens, Fundamentals of Medical Imaging, Cambridge University Press (2005) H.H. Barret and W. Swindell, Radiological Imaging: The Theory of Image Formation , Detection, and Processing, Academic Press (1981) P. Sprawls. The Physical Principles of Medical Imaging, Medical Physics Pub Corp (1995)				

Code:	134	Subject:	Physical Basis of Radiotherapy	
Speciality/module			ECTS credits	Type
Radiophysics			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Production and interaction of high energy particles. Dosimetry of radiation beams used for radiotherapy. Dose calculation methods and algorithms. Teletherapy and Braquitherapy techniques				
Bibliography				
The Physics of Radiation Therapy F. M. Khan. Lippincott Williams & Wilkins, 2003. Physics of Radiotherapy X-Rays from Linear Accelerators P. Metcalfe, T.Kron, F. Hoban. Medical Physics Publishing Corporation, 1997-06. Radiation Therapy Physics W.R Hendee, G.S. Ibbot, E.G. Hendee. John Wiley 2005 Clinical Radiotherapy Physics S. Jayaraman, L.H. Lanzl, E.F. Lanzl.Springer, 2004.				

Code:	135	Subject:	Bioenergetics
Speciality/module		ECTS credits	Type
Biophysics Complements		3	Optional Subject
Lectures hours		Practical hours	Personal work
15		7	50
Contents			
Bioenergetics general laws. Classification of the different types of energy interaction in Biology. Energy interactions: thermodynamic and thermokinetics considerations. Energy interaction with matter transference. Oxidative phosphorylation. Photosynthesis.			
Bibliography			
Nicholls, D.G. y Ferguson, S.T. <i>Bioenergetics 3</i> . Academic Press. London (2002) Montero F. y Morán F.; <i>Biofísica. Procesos de autoorganización en biología</i> . Eudema. Madrid (1992) Haynie, D.T. <i>Biological Thermodynamics</i> . Cambridge University Press. Cambridge (2001) Ernster, L. <i>Molecular Mechanisms in bioenergetics</i> . Elsevier. Amsterdam (1992)			

Code:	136	Subject:	Physics of Biomembranes	
Speciality/module			ECTS credits	Type
Biophysics Complements			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Transport through the membrane. Electrical phenomena in biological membrane. Ion channels. Membrane potentials. Excitable membranes. Membrane balance. Interface phenomena. Adhesion. Adsorption				
Bibliography				
<i>“Biophysics”</i> Roland Glaser. Ed. Springer (2001). <i>“Biophysics an Introduction”</i> Rodney Cotterill. Ed. John Willey & Sons (2003). <i>“Física Biológica. Energía, información, vida”</i> Philip Nelson. Ed. Reverté (2005).				

Code:	137	Subject:	Nuclear Magnetic Resonance	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation Complements			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	105
Contents				
Physical bases of NMR. NMR Spectroscopy. NMR Imaging. Instrumentation for NMR. Metabolism by NMR. Morphology by NMR. Function by NMR. Compatible and non-compatible instruments and materials with NMR.				
Bibliography				

Code:	138	Subject:	Ultrasounds in Medicine	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation Complements			3	Optional Subject
Lectures hours			Practical hours	Personal work
15			7	50
Contents				
Physical foundations. Ultrasound generators. Piezoelectric devices. Pulse-echo techniques. 2D, 3D and 4D echography. Therapy with ultrasounds.				
Bibliography				
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Code:	139	Subject:	Physics of Vision	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation Complements			3	Optional Subject
Lectures hours			Practical hours	Personal work
15			7	50
Contents				
The light and the spectral sensitivity of the human visual system (HVS). Physiology of the HVS. Characteristics of the HVS: adaptation. Space-temporal visual perception. Processing of visual information. Photoreceptors optics. Optical transduction mechanisms. A basic comparative study of the visual system in vertebrates and invertebrates. Models for vision. Colour vision.				
Bibliography				
Artigas J.M., Capilla P., Felipe A., Pujol J., <i>Óptica Fisiológica. Psicofísica de la visión</i> . Interamericana McGraw-Hill, Madrid, 1995. De Valois R.L., De Valois K., <i>Spatial Vision</i> , Oxford Science and Publications, Oxford 1988. Enoch J.M., Tobey F.L., Jr., <i>Vertebrate Photoreceptor Optics</i> , Springer-Verlag, Berlin, 1981. Dartnall H.J.A. (Ed.), <i>Handbook of Sensory Physiology. Photochemistry of Vision</i> . Volume VII/1. Springer-Verlag, Berlin, 1972. Capítulo 4. Photosensitivity. Dawson W.W., Enoch J.M., <i>Foundations of Sensory Science</i> , Springer-Verlag, Berlin, 1984. Capítulo 7: “The perception of light and colour” (Fry G.A.), Capítulo 9: “Optics and vision” (Fry G.A.). Bass M. (Ed.), <i>Handbook of Optics. Fundamentals, techniques and design</i> . Volumen I, segunda edición, Optical Society of America, McGraw Hill, Nueva York, 1995. Parte 7. Vision. Calvo M.L., Limeres J., ¿Puede la física interpretar el comportamiento de los fotoreceptores de la retina?, <i>Ver y Oír</i> , Octubre 2002.				

Code:	140	Subject:	Laser in Medicine	
Speciality/module		ECTS credits		Type
Biomedical Instrumentation Complements		3		Optional Subject
Lectures hours		Practical hours		Personal work
23		23		90
Contents				
Laser physics fundamentals. Laser types. Lasers in ocular surgery. Lasers in gynecology. Other surgeries: dermatology, urology, orthopaedic medicine, plastic surgery, oral surgery. Photodynamics therapy. Noninvasive treatments. Laser and normative security.				
Bibliography				
Física del Láser, J.M. Guerra, Ed.Alqua (libro libre) 2005. Can be downloaded for free from: http://www.ucm.es/info/laserlab/docencia.html Laser Institute of América (professional advancement series), Laser output characteristics. Laser safety in Surgery and Medicine, Editor: R. James Rockwell Jr, Ed. Rockwell Associates Inc. Environmental Health Criteria (23), Lasers and Optical Radiation, Ed. World health Organization				

Code:	222	Subject:	Biomedical Instrumentation Principles	
Speciality/module			ECTS credits	Type
Biomedical Instrumentation Complements			6	Optional Subject
Lectures hours			Practical hours	Personal work
30			15	75
Contents				
Linear systems. Electrical measurement, filtering and amplification. Optical instrumentation applied to diagnose. Instrumentation applied to therapy and rehabilitation. Instrumentation applied to cellular research.				
Bibliography				

Code:	141	Subject:	Projects in Companies or Official Institutions	
Speciality/Module			ECTS Credits	Type
			24	Compulsory subject
Lectures hours			Practical hours	Personal work
0			0	180
Contents				
Works in diverse fields will be offered in collaboration with Madrid hospitals, practical works in companies of the sector and research initiation works both in university groups and outside the University.				
Bibliography				

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