COURSE GUIDE FOR

INSTRUMENTAL TECHNIQUES APPLIED TO BIOTECHNOLOGY

Academic year 20-21

(Date last update: 30/06/2020)
(Date approved in Department Council: 30/06/2020)

MODULE	SUBJECT MATTER	YEAR	SEMESTER	CREDITS	TYPE
Technological	Instrumental techniques applied to biotechnology	1st	2nd	6.0	Compulsory

TEACHING STAFF[1]	ADDRESS, TELEPHONE NUMBER, EMAIL, ETC. DIRECCIÓN COMPLETA DE CONTACTO PARA TUTORÍAS (Dirección postal, teléfono, correo electrónico, etc.) **Dpt. Fisicoquímica**, 2nd floor, Faculty of Pharmacy. Room 199. e-mail: jmparedes@ugr.es Tel. 958 243829
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	TIMETABLE FOR TUTORIALS OR LINK TO WEBSITE
	http://fisicoquimica.ugr.es/pages/docencia/curso_2021/_doc/horariotutorias2021
BELONGS TO UNDERGRADUATE DEGREE PROGRAMME	AND ALSO TO OTHER UNDERGRADUATE DEGREE PROGRAMMES
Biotechnlogy	

PREREQUISITES OR RECOMMENDATIONS (where applicable)

- Suitable knowledge of Chemistry, high-school level.
- Basic knowledge on mathematical operations (logarithmic and exponential functions, use of calculator, etc.).

BRIEF DESCRIPTION OF CONTENT (ACCORDING TO OFFICIAL VALIDATION REPORT)

Interactions between radiation and matter. Main components in spectroscopic techniques. Atomic absorption and emission spectroscopy. Molecular absorption spectroscopy. Emission spectroscopy. Nuclear magnetic resonance

[1] Consult any updates in Acceso Identificado > Aplicaciones > Ordenación Docente
(∞) This course guide should be filled in according to UGR regulations on assessment of student learning: (http://secretariageneral.ugr.es/pages/normativa/fichasugr/ncg7121/!)

spectroscopy. Mass spectrometry.

GENERAL AND SPECIFIC COMPETENCES

Basic: CB2, CB3, CB5
General: CG1, CG2, CG4, CG5, CG7
Transversal: CT3, CT5, CT8, CT9
Specific: CE28

DETAILED SYLLABUS

LECTURES:

Unit 1.- Absorption of light and main components for optic spectroscopy.

Nature of the electromagnetic radiation. Regions of the electromagnetic spectrum. Molecular energy levels. Selection rules. Lambert-Beer's Law. Deviations from Beer's Law. Range of minimum error. Components and configurations of instruments for optic spectroscopy. Light sources. Wavelength selectors. Light detectors.

Unit 2.- Atomic spectroscopy.

Introduction to atomic spectroscopy. Atomic spectra and selection rules. Effect of the temperature on the atomic spectra. Sample atomization. Sample introduction. Atomic absorption spectroscopy. Radiation sources. Flame atomizers. Electrothermal atomizers. Types of spectrophotometers. Interferences. Atomic emission spectroscopy. Atomizers. Inductively coupled plasma (ICP). Types of spectrophotometers. Applications. Flame photometry. Comparison between the different atomic spectroscopy techniques.

Unit 3.- IR spectroscopy.

IR radiation. Vibration of diatomic molecules and potential energy curves. Absorption of IR radiation. Selection rules. IR spectra and force constant in diatomic molecules. Anharmonicity. Vibration of polyatomic molecules. Instrumentation for IR spectroscopy. IR spectra of biopolymers.

Unit 4.- UV-vis absorption spectroscopy.

Electronic spectra: vibration structure of the electronic bands. Selection rules. Electronic transitions in polyatomic molecules. Chromophore and auxochrome groups. Instrumentation. UV-vis spectra of biopolymers: proteins and nucleic acids. Conformational effects on the absorption: sensitivity to the local environment, and chromophore interactions. Optical rotatory dispersion. Circular dichroism and protein structure.

Unit 5.- Emission spectroscopy I.

Introduction to fluorescence emission. Features of the fluorescence emission. Monomolecular processes of excited-state deactivation. Fluoresnce quantum yield and lifetime. Steady-state fluorescence spectra and time-resolved fluorimetry. Instrumentation. Factors affecting the fluorescence emission: Kavanagh's Law. Intrinsic and extrinsic fluorophores. Labelling of molecules, biomolecules, and macrostructures. Quimioluminescence and bioluminescence.

Unit 6.- Emission spectroscopy II.

Solvent effects. Determination of the environment polarity. Solvent relaxation. Time-Resolved Emission Spectroscopy (TRES). Fluorescence quenching: static, dynamic, and sphere of action quenching. Fluorescence Resonance Energy Transfer (FRET). FRET pairs. FRET as a spectroscopic ruler. FRET for determining molecular associations. FRET for studying membranes. Fluorescence polarization and anisotropy. Fluorescence anisotropy to study molecular associations and membranes. Fluorescence correlation spectroscopy (FCS). FCS to study molecular diffusion and reactions. Fluorescence microscopy and fluorescence lifetime imaging microscopy (FLIM). Single-molecule fluorescence spectroscopy. Semiconductor nanocrystals: quantum dots. DNA sequencing.

Unit 7.- Nuclear Magnetic Resonance.
Principles of NMR. Instrumentation. Features of NMR spectra. Chemical shift. Multiplicity. Proton NMR spectra of biological systems. ^{13}C-NMR spectra of proteins. ^{31}P-NMR spectra. ^{19}F-NMR spectra of biological systems. NMR spectra of nucleic acids.

Unit 8.- Mass spectrometry.
Physical fundamentals. Ionization and fragmentation. Ionization methods: gas phase and desorption (electrospray and MALDI). Mass analyzers. Detectors. Mass spectra. Molecular and structural information.

LABORATORY SESSIONS AND SEMINARS:
Seminars

- Problems solving

Laboratory sessions

- **Session 1.** ***Protein determination by UV-vis spectroscopy.***
- **Session 2.** ***Dynamic quenching***.
- **Session 3.** ***Molecular distances measured by FRET.***
- **Session 4**. ***FTIR-ATR for structural information of organic molecules and proteins***.

BIBLIOGRAPHY

- **Principios de Análisis Instrumental.** (6ª Edición). D.A. Skoog, F.J. Holler, S. R. Crouch. Ed. McGraw-Hill.
- **Methods in Molecular Biophysics. Structure, Dynamics, Function.** I.N. Serdyuk, N.R. Zaccai, J. Zaccai. Cambridge University Press.
- **Principles of Fluorescence Spectroscopy.** (3rd Ed.). J. R. Lakiwicz. Springer.
- **Análisis Instrumental.** K.A. Rubinson, J.F. Rubinson. Prentice-Hall.
- **Chemical Analysis. Modern Instrumentation, Methods and Techniques.** (2nd Ed.). F. Rouessac, A. Rouessac. Ed. Wiley.

RECOMMENDED LINKS

UC Davis ChemWiki online resources
http://chemwiki.ucdavis.edu

William Reusch Virtual Textbook of Organic Chemistry
http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm

IR, RMN and mass spectrometry database: SDBSWeb:
http://sdbs.db.aist.go.jp
(National Institute of Advanced Industrial Science and Technology, accessed 5/12/2014)

Beer's Law
http://www.chm.davidson.edu/ChemistryApplets/spectrophotometry/BeersLaw.html

IR spectroscopy:
http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Spectrpy/InfraRed/infrared.htm#ir1

UV-vis spectroscopy:
http://teaching.shu.ac.uk/hwb/chemistry/tutorials/

NMR spectroscopy:
http://www.cis.rit.edu/htbooks/nmr/inside.htm

NMR exercises:
http://www.chem.ucla.edu/~webspectra/#Problems

Mass spectroscopy:
http://www.astbury.leeds.ac.uk/facil/MStut/mstutorial.htm

TEACHING METHODOLOGY

- Master classes for theroy teaching
- Practical seminars regarding application problems of each lesson
- Practical lessons in the laboratory
- Quiz and test from online platforms for continuous evaluation

ASSESSMENT (ASSESSMENT INSTRUMENTS, CRITERIA AND PERCENTAGE VALUEOF FINAL OVERALL MARK, ETC.)

All the evaluation processes will be carried out according to the normative of the University of Granada.

1. Ordinary call

- Written exams about theoretical concepts. Percentage of the final mark: 50-55%.
  There will be a mid-course exam and a final exam.
  The qualification considered in this section will be the mark obtained in the final exam. If the subject has been passed by overcoming both mid-course and final exam, the qualification will be the average between them.

- Written exams about mathematic resolution of application problems. Percentage of the final mark: 25-30%.
  There will be a mid-course exam and a final exam.
  The qualification considered in this section will be the mark obtained in the final exam. If the subject has been passed by overcoming both mid-course and final exam, the qualification will be the average between them.

- Practical lessons. Percentage of the final mark: 10%.
  It is compulsory to attend to all practical lessons. The global mark is divided in two tasks:
  - Laboratory book 30%
  - Exam about practical contents : 70%

- Continuous evaluation and attending to theoretical classes. 10%.

2. Extraordinary call and single final evaluation

- Written exams about theoretical concepts. Percentage of the final mark: 55-60%.
  There will be a mid-course exam and a final exam.
  The qualification considered in this section will be the mark obtained in the final exam. If the subject

has been passed by overcoming both mid-course and final exam, the qualification will be the average between them.

- Written exams about mathematic resolution of application problems. Percentage of the final mark: 30-35%.
  There will be a mid-course exam and a final exam.
  The qualification considered in this section will be the mark obtained in the final exam. If the subject has been passed by overcoming both mid-course and final exam, the qualification will be the average between them.
- Practical lessons. Percentage of the final mark: 10%.

DESCRIPTION OF THE EXERCISES WHICH WILL CONSTITUTE SINGLE FINAL ASSESSMENT AS ESTABLISHED IN UGR REGULATIONS

- This description is reported in the assessment section

SCENARIO A (ON-CAMPUS AND REMOTE TEACHING AND LEARNING COMBINED)

TUTORIALS

TIMETABLE (According to Official Academic Organization Plan)	TOOLS FOR TUTORIALS (Indicate which digital tools will be used for tutorials)
https://fisicoquimica.ugr.es/pages/docencia/curso_2021/_doc/horariotutorias2021	There will be both on-site and virtual tutorials. Proposed telematic media are: Forums in virtual platform (PRADO) . e-mail

MEASURES TAKEN TO ADAPT TEACHING METHODOLOGY

- **Theory lessons**: Teaching methodology will be the same proposed in the previous section about "teaching methodology". In this case, the master classes will be broadcasted in real time to those students that can not attend if the number of people in the classes is limited by the health situation.
- **Practical lessons**: Due to the limited capacity of the facilities of the faculty there will be two days of practical lessons in the lab and two days of virtual lessons, concerning to the theoretical aspects of the two on-site tasks.
- **Continuous evaluation**. In these cases methodology will be the same proposed in the previous section about "teaching methodology" and there will be preferentially developed on-site. In case there will be capacity limitation virtual media will be used (Google Meet, PRADO Kahoot, etc).

MEDIDAS DE ADAPTACIÓN DE LA EVALUACIÓN (Instrumentos, criterios y porcentajes sobre la calificación final)

Ordinary assessment session

- Adaptative measures have only been proposed for the practical lessons. The written examns of this section will be in virtual through the PRADO platform. The percentages are those described in the assesment section

Extraordinary assessment session

- Adaptative measures have only been proposed for the practical lessons. The written examns of this section

will be in virtual through the PRADO platform. The percentages are those described in the assesment section.

For those students that have attended to the practical lessons and have not passed the exam there will be a virutal written exam in the PRADO platform.

Those students that have not atended to the practical lessons will have to pass a practical exam in the laboratory. The evaluation will be carried out by the teachers in charge of the practical lessons.

Single final assessment

- There is no adaptative measures in this type of assessment

SCENARIO B (ONCAMPUS ACTIVITY SUSPENDED)

TUTORIALS

TIMETABLE (According to Official Academic Organization Plan)	TOOLS FOR TUTORIALS (Indicate which digital tools will be used for tutorials)
https://fisicoquimica.ugr.es/pages/docencia/curso_2021/_doc/horariotutorias2021	There will exclusively virtual tutorials. Proposed telematic media are: Forums in virtual platform (PRADO) -Google meet -email communication

MEASURES TAKEN TO ADAPT TEACHING METHODOLOGY

- Theory:
  - Synchrony classes through Google-Meet
  - Recorded videos of the theoretical lessons.
- Practial lessons:
  - All the practical lessons will be virtual and attending is compulsory by Google-Meet videoconference.
- Seminars:
  - The seminars related with the application problems will be taught by Google Meet. Students will provide the solutions by PRADO or email.
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- Continuous assessment:
  - Quiz, test and games through PRADO, SWAD and Kahoot.

MEASURES TAKEN TO ADAPT ASSESSMENT (Instruments, criteria and percentage of final overall mark)

Ordinary assessment session

- Written exams about theoretical concepts. . Percentage of the final mark: 42-58%.
  Individual exams by PRADO platform.

- Written exams about theoretical concepts. . Percentage of the final mark: 22 - 38%.

Individual exams by PRADO platform

- Practical lessons assessment. Percentage of the final mark: 10%, divided in two tasks:
  Laboratory book 30%
  Exam about practical contents : 70%

- Continuous assessment. Percentage of the final mark: 10-20%.

Extraordinary assessment session

- Written exams about theoretical concepts. . Percentage of the final mark: 55-60%.
  - Individual exams by PRADO platform.
- Written exams about theoretical concepts. . Percentage of the final mark: 30 - 35%.
  Individual exams by PRADO platform

- Practical lessons assessment. Percentage of the final mark: 10%,

Single final assessment

- Written exams about theoretical concepts. . Percentage of the final mark: 55-60%.
  Individual exams by PRADO platform.

- Written exams about theoretical concepts. . Percentage of the final mark: 30 - 35%.
  Individual exams by PRADO platform

- Practical lessons assessment. Percentage of the final mark: 10%,
  For those students that have attended to the practical lessons and have not passed the exam there will be a virutal written exam in the PRADO platform.

  Those students that have not atended to the practical lessons will have to pass a practical exam in the laboratory. The evaluation will be carried out by the teachers in charge of the practical lessons

ADDITIONAL INFORMATION (if necessary)

The move to scenario A to scenario B will be impossed by the health authorities determination due to the evolution of the pandemic caused by COVID-19.