Universidad de Navarra

Physical Chemistry (F. Ciencias)

Guía docente 2025-26

PRESENTACIÓN

Breve descripción:

- **Titulación**: Degree in Biochemistry-14
- **Módulo/Materia**: Chemistry for Molecular Biosciences/ General Chemistry
- **ECTS**: 6
- **Curso, semestre**: 1st year, 2nd semester
- **Carácter**: compulsory
- **Profesorado**: Prof. Gustavo González Gaitano, Prof. Marta Fuentes Ramírez, Prof. Javier Erro Garcés
- **Idioma**: English
- **Aula, Horario**: see School of Sciences website

RESULTADOS DE APRENDIZAJE (Competencias)

Competencias específicas

CE1 Analizar problemas cualitativos y cuantitativos en Bioquímica a través de hipótesis científicas que puedan examinarse empíricamente.

CE2 Aplicar las técnicas e instrumentos propios de la experimentación en Bioquímica, Biología y Biología Molecular con seguridad.

CE3 Conocer bien los fundamentos de la Física y la Química relevantes para entender los procesos biológicos y bioquímicos y adquirir destreza en las operaciones experimentales básicas para trabajar de forma segura y eficaz en un laboratorio.

Competencias generales y básicas

CG1 Planificar y organizar el tiempo y gestionar la propia formación continua, actualizando el conocimiento de las innovaciones del ámbito científico y saber analizar las tendencias de futuro.

CG2 Pensar de forma integrada y abordar los problemas desde diferentes perspectivas. Tener razonamiento crítico. Aportar soluciones a problemas en el ámbito científico.

CG6 Trabajar de forma adecuada en un laboratorio con material químico y/o biológico, incluyendo seguridad, manipulación y eliminación de residuos, registro anotado de actividades e interpretación de los resultados.

CB1 Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel, que si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.

CB4 Que los estudiantes puedan trasmitir información, ideas y soluciones a un público tanto especializado como no especializado.

PROGRAMA

Part I: Thermodynamics

1. The first law. Fundamentals of Thermodynamics. Reversible and irreversible processes. Heat capacity. Mathematical expression of the first law. Enthalpy. Types of thermodynamic processes. Physical changes and intermolecular forces. Chemical changes. Biological fuels.Enthalpy of reaction and its variation with the temperature.

2. The second law. Entropy. Absolute entropies. Third law and microscopic interpretation of the entropy. Entropy in physical and chemical changes. The Gibbs energy and spontaneity of thermodynamic processes. The hydrophobic effect.

3. Phase equilibria. Variation of Gibbs energy with temperature and pressure. Phase diagrams. Expression of the concentration. The chemical potential. Thermodynamic description of mixtures. Ideal solutions, ideal-dilute solutions, real solutions (activities). Colligative properties and application to the characterization of biopolymers.

4. Chemical equilibrium. Gibbs energy and equilibrium constant. Response of equilibria to the conditions. Biological standard states. Ligand-macromolecule systems. Cooperative binding. Proton transfer equilibria: polyprotic acids, amphiprotic systems, aminoacids, buffer solutions.

Part II. Kinetics, transport phenomena, and spectroscopy

5. Transport of ions and electrons. Ions in solution: Debye-Hückel theory and activity coefficients. Membrane potential. Redox reactions and standard potentials in biological systems. Nernst equation and applications.

6. Fundamentals of spectroscopy. Types of spectroscopy. Beer's law. UV-visible spectroscopy and applications. Fluorescence spectroscopy. Quenching of fluorescence.

7. Chemical kinetics. Reaction rate and rate law. Integrated rate law. Dependence with the temperature. Mechanisms of reaction: elementary, consecutive and reversible reactions. Reaction dynamics: collision and transition state theories.

8. Transport properties. Diffusion and Fick's laws. Molecular transport across membranes. Sedimentation. Conductivity and electrokinetic phenomena.

Lab sessions

Fundamentals of UV-vis spectroscopy

Rate law and temperature dependence on the reaction rate.

Protein-ligand binding.

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ACTIVIDADES FORMATIVAS

Activities

- Lectures, prior to the laboratory work. The supervisor will present the theoretical background, methodology of the experiment and objectives. The documentation necessary will be available in intranet ADI.
- Practical sessions under the guidance of the supervisor. The attendance of these sessions is compulsory for the students.
- Seminars, assigned to the students.
- Tutorships.
- Personal work, dedicated to the preparation and study of each experiment, and study of the subject and making of the reports.
- Evaluation (see Evaluation section).

Time distribution

- Classes: 45 h
- Seminars: 10 h distributed over the term
- Laboratory: 12 h (The detailed schedule of the laboratory sessions will be handed to the student at the beginning of the semester)
- Tutorship: variable according to the student's needs
- Examination: final exam (5 h max.), one partial exam (3 h max.), one lab exam (1 h max.)
- Ca. 60 h of personal study, work in group for solving problems, preparation of results, etc.

EVALUACIÓN

CONVOCATORIA ORDINARIA

The overall mark is the average of two exams (March and May), weighing the 85%. The remaining 15% corresponds to the lab part.

Exams consist of a test and questions in the form of demonstrations and/or numerical problems.

If any of the two parts has been passed (5.0), it does not need to be repeated in May or June. In case the student wants to obtain a higher qualification it is possible to take exam of that part in May.

The lab mark corresponds to the lab exam. The attendance to the lab sessions is mandatory. Any absence must be duly justified: unexcused absences to practical sessions count -1.5 in the final grade.

Seminars will be assigned to the student (or couples if the group is large) to present them in class. This permits obtaining +0.5 in the final grade (only applies if the mark in each part of the subject is higher than 4.0). The exercise assignation will be announced in due time.

Students with special educational needs must contact the Study Coordinator in advance to obtain authorization for extending the exam time. This authorization must be sent by the student to the professor at the beginning of the semester.

ATTENTION: Please note that any attempt at fraud, copying, plagiarism, or other irregular behavior constitutes a serious violation, as defined in Title IV "Normas de disciplina académica de los estudiantes" (Sistema de normas sobre la convivencia en la Universidad de Navarra).

CONVOCATORIA EXTRAORDINARIA

Same criteria as in May.

HORARIOS DE ATENCIÓN

Please, contact:

Prof. Gustavo González Gaitano (gaitano@unav.es), Research Building, office 1-171

Prof. Marta Fuentes Ramírez (martafuentes@unav.es), Hexagon building, office 3D02

Prof. Javier Erro Garcés (jerrogar@unav.es), Hexagon building, office 3D02

BIBLIOGRAFÍA

Textbooks

Atkins, P., de Paula J. (2011). "Physical Chemistry for the Life Sciences". 2ª ed. Ed. Oxford University Press Find it in the Library

Bohorquez, M. (2006) "Solutions manual for Physical chemistry for the life sciences (1ª ed.)" . Ed. W.H. Freeman Find it in the Library

Trapp, C. (2011) "Solutions manual to accompany Physical chemistry for the life sciences (2nd ed.) Ed. Oxford University Press Find it in the Library

Chang R. (2008) "Fisicoquímica para las Ciencias Químicas y Biológicas". Ed. McGraw-Hill Find it in the Library

Atkins, P., de Paula J. (2008). "Química Física" 8ª ed. Ed. Médica Panamericana Find it in the Library

Tinoco I., Sauer K., Wang J.C. (2003) “Physical Chemistry. Principles and Applications in Biological Sciences”. Ed. Prentice-Hall Find it in the Library

Price N.C., Dwek R.A., Ratcliffe G., Wormanld M.R. (2001) “Principles and Problems in Physical Chemistry for Biochemists” Ed. Oxford University Press Find it in the Library