



1. PRESENTACIÓN

Descripción de la asignatura:

Course in Physical Chemistry oriented to Life Sciences (specifically Biochemistry), covering the most relevant areas and applications for biochemists: Thermodynamics, chemical kinetics, transport phenomena and fundamentals of electronic molecular spectroscopy.

Datos Generales

Titulación: GRADO EN BIOQUÍMICA 2026

- **Módulo:** MATEMÁTICAS, FÍSICA Y QUÍMICA; Materia 1.2: BASES QUÍMICAS DE LOS SISTEMAS BIOLÓGICOS
- **Curso:** 1º, **semestre:** 2º
- **Carácter:** OBLIGATORIA
- **Profesor:** (español e inglés) GUSTAVO GONZÁLEZ GAITANO (responsable español e inglés), MARTA FUENTES RAMIREZ, JAVIER ERRO GARCES
- **Idioma:** INGLÉS

2. RESULTADOS DE APRENDIZAJE

- RA3. Explicar los fundamentos de la Física y la Química relevantes para entender los procesos biológicos y bioquímicos.
- RA12. Manipular material químico y/o biológico, incluyendo seguridad, eliminación de residuos, registro anotado de actividades e interpretación de los resultados.

3. PROGRAMA TEÓRICO Y PRÁCTICO

Programa teórico

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 and real solutions (activities). Phase transitions in biopolymers. Colligative properties and applications 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. **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.



6. 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.

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

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

Programa práctico

1. Fundamentals of UV-vis spectroscopy.
2. Rate law and temperature dependence on the reaction rate.
3. Protein-ligand binding.

4. ACTIVIDADES FORMATIVAS

Actividades presenciales

- Lectures: 42 h.
- Laboratory sessions: 10 h (Practical sessions under the guidance of the supervisor. The attendance of these sessions is mandatory for the students. The supervisor will present the theoretical background, methodology of the experiment and objectives).
- Presentations in class (seminars): 8 h (in the form of problem seminars, assigned to the students at the beginning of the semester).
- Evaluation: 3 h (see Evaluation section).

Actividades no presenciales

- Personal work, dedicated to the preparation and study of the topics, seminars and preparations of practical sessions: 90 h.

5. EVALUACIÓN

Convocatoria ordinaria

- The total mark is the average of two exams (March and May), weighing the 85%. The remaining 15% corresponds to the practicals. The exams consist of a test (ca. 40 items) and short questions in the form of demonstrations and/or numerical problems (3-4), weighing 50%, each part. 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 practicals 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. The lab sessions are optional for students retaking the subject (the exam is mandatory).
- 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 or equal than 4.0). The exercise assignation is announced in due time.

Convocatoria extraordinaria

- Same criteria as in May.

Estudiantes con necesidades educativas especiales



- For students with special educational needs, exceptions will be allowed regarding the methodology and/or assessment of the subject. Possible alternatives will be explored as long as they guarantee the effective acquisition of all required skills.

6. EVALUACIÓN DE LOS RESULTADOS DE APRENDIZAJE

(Indicar de qué forma se va a evaluar en la asignatura cada uno de los resultados de aprendizaje)

	Examen teórico	Evaluación de las prácticas	Trabajos escritos	Presentaciones orales	Evaluación continua en el aula	Otros (especificar)
RA3	X	X		X		
RA12		X				

Aunque no evaluables cuantitativamente, con el aprendizaje de la asignatura el alumno debería llegar a adquirir las siguientes competencias generales y básicas:

- BQ-RA21: Mostrar admiración ante la complejidad de la vida a escala molecular
- BQ-RA23: Afrontar de manera crítica y reflexiva el estudio de la propia disciplina en su conexión con el resto de los saberes.

7. ATENCIÓN AL ALUMNO

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

8. BIBLIOGRAFÍA

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](#)

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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](#)