LF101-12 Physical Chemistry for Biochemists

20/21

Department
Life Sciences
Level
Undergraduate Level 1
Module leader
Yuriy Pankratov
Credit value
12
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

To provide the physical chemistry basis for second year and third year modules in Enzymology (BS258), Biological Spectroscopy (BS258) , Bioenergetics (BS239), Structural Molecular Biology (BS348), and Biophysical Chemistry (BS353).

Module web page

Module aims

Understanding of basic principles of chemical kinetics and basic laws of thermodynamics in the context of biological systems and living cells. Understanding of relationships between reaction mechanism, free energy and the rate law.
Appreciation of main experimental and theoretical approaches to elucidate kinetics of biochemical reactions. Appreciation for heterogeneity and complexity of biochemical reactions and impact of solvent, diffusion and interaction with membrane proteins on their kinetics
Ability to apply the basic equations governing thermodynamics and simple kinetic models to evaluate qualitative relationships in different area of biological sciences.
Improvement of numerical and analytical skills and problem-solving abilities and increasing

confidence in understanding new concepts and testing complex hypotheses

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

IIntroduction to Quantitative Biology 1 lecture

The history of the application of physical principles
Kinetics and biological problems
Time scales of nature and of measurement
The origins of exponential behaviour
Concepts of fluctuations and statistics (deviations from the mean, number fluctuations, Poisson distribution)
Fundamental mathematical concepts (limits, derivative, integral, differential equations)
Guidelines for the derivation of equations used in the module

Kinetics 5 lectures and 3 workshops

The law of mass action, rates and equilibria
Rate constant and order of reaction
Rate Laws and reaction mechanisms (0, 1st, 2nd order reactions and fractional)
Collision theory, transition state theory and Arrhenius equation
Steady-state approximation
Methods for measuring reaction kinetics and determining rate constants, modelling of kinetic mechanisms
Enzyme Kinetics (Michaelis–Menten kinetics, inhibition, allosteric enzymes; enzyme reactions in metabolism)
Factors affecting rates of reactions (Temperature dependence of reactions and activation parameters, viscosity and molecular dynamics, diffusion control of reactions)
Kinetic analysis of complex reactions (Introduction to the study of transients and reaction sequences; kinetics of electron transfer and free-radical reactions; polymerization kinetics)
Kinetics of biomolecular reactions and introduction to molecular pharmacology (kinetics of protein-ligand binding and exchange between; binding sites, single-site and multiple independent sites models, binding to membrane receptors, reduction in dimensionality)

Thermodynamics 7 lectures and 4 workshops
Basic concepts of thermodynamics 3 lectures
Three laws of thermodynamics
Enthalpy, Entropy, Gibbs free energy
Chemical potential and activities

Reversible processes, equilibrium, Effect of temperature on Equilibrium constant
Phase transitions, effect of solutes on boiling points and freezing points
Ionic solutions, Acids and bases
Standard state in biochemistry

Biological thermodynamics 4 lectures
Redox reactions

Energy conservation and exchange in the living organism (photosynthesis, glycolysis, Oxidative phosphorylation, ATP hydrolysis)
Membrane transport and equilibrium (osmosis, dialysis, Donnan equilibrium active and passive transport)
Dynamics of macromolecules (DNA melting, protein solubility, stability and folding, pathological misfolding)

Introduction to Quantum Mechanics and Quantum Biology 2 lectures
Quantum Phenomena (photoelectric effect, de Broglie relationship)
The Schrodinger Equation
Physical interpretation of the wave function
Heisenberg's uncertainity principle
General Spectroscopy (light and matter, photons and electrons)
Electronic and Molecular states and Energy Levels
Quantum phenomena in biological systems (photosynthesis, olfactory and light perception, magnetoreception)

Applications of Physical Chemistry to Complex Biological Systems 2 lectures
The 3 Laws and biological evolution: energy, information and life, entropy and complexity, formation of the first biological macromolecules and cells.
Kinetics and thermodynamics of physiological responses (sensory systems, muscle contraction and molecular motors). Basic priciples of Turing's theory and its link to the development of complexity and patterns in multicellular systems.

Learning outcomes

By the end of the module, students should be able to:

- appreciate the importance of quantitative approach to analysis of chemical and physical processes in different areas of life sciences describe the basic physical concepts and practical mathematical techniques used in analysing and understanding of interactions between biological molecules. understand the relation of laws of thermodynamics to life and evolution and apply the simple kinetic models to evaluate qualitative relationships in different area of biological sciences. develop numerical and analytical skills and problem-solving abilities.

Subject specific skills

appreciate the importance of quantitative approach to analysis of chemical and physical processes in different areas of life sciences
describe the basic physical concepts and practical mathematical techniques used in analysing and understanding of interactions between biological molecules.
understand the relation of laws of thermodynamics to life and evolution and apply the simple kinetic models to evaluate qualitative relationships in different area of biological sciences.

develop numerical and analytical skills and problem-solving abilities.

Transferable skills

1. Self directed learning
2. Analytical skills
3. Physics and chemistry associated with biology

Study

Study time

Type	Required
Lectures	19 sessions of 1 hour (16%)
Practical classes	11 sessions of 1 hour (9%)
Private study	90 hours (75%)
Total	120 hours

Private study description

Self-directed learning and preparation for the end of year exam

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

	Weighting	Study time
Online Examination MCQ / Short answer exam paper	100%	

- Online examination: No Answerbook required

Feedback on assessment

Post-board cohort level feedback

Past exam papers for LF101

Availability

Courses

This module is Core for:

- Year 1 of UBSA-C700 Undergraduate Biochemistry
- ULFA-C1A2 Undergraduate Biochemistry (MBio)
    - Year 1 of C1A2 Biochemistry
    - Year 1 of C700 Biochemistry
- Year 1 of ULFA-C702 Undergraduate Biochemistry (with Placement Year)
- Year 1 of ULFA-C1A6 Undergraduate Biochemistry with Industrial Placement (MBio)