LUND UNIVERSITY
Faculty of Science

Syllabus for the course The biophysical chemistry of proteins, NAKE008

Swedish title: Proteiners biofysikaliska kemi

The course syllabus was confirmed by the Faculty board for graduate studies on 22 February 2017. Third cycle course, 15 credits.
This is a translation of the course syllabus approved in Swedish.

Learning outcomes
Deepened knowledge on the biophysical chemistry of proteins with emphasis on properties rather than methods. Upon completion of the course, the student shall be able to:

Knowledge and understanding
- Describe the structures and functions of several protein families
- Describe physical properties of proteins including surface properties and hydrodynamics
- Define the molecular driving forces that govern the, structure, folding and stability of proteins
- Demonstrate acquaintance with the literature in the area, including classical as well as recent papers

Skills and abilities
- Calculate accessible surface area and other properties for proteins with known structure
- Analyse ligand binding and protein stabilitet
- Use the literature and databases to improve the scientific level of protein research projects.

Evaluation ability and approach
- Explain protein properties and phenomena from a physicochemical perspective
- Discuss and evaluate both fundamental texts and advanced applications in the area.
- Summarize the knowledge level in classical as well as modern literature in the area.

Course content
The course is set up around the following topics:

Protein sequences
- Physicochemical properties of the amino acid side chains
- Ionizable groups in side chains and backbone
- Chemical properties of the amino acid side chains (reactivity and modifications)
- Benefits and constraints imposed by the covalent chain

Protein targeting and modification
- Signal peptides, membrane anchors
- Post translational modification
- Non-canonical amino acids, glycosylation, protein splicing, intein-mediated ligation

Protein structure taxonomy
- What folds are represented in nature?
- What are the dominant folds?
- Structure and relation to Function. What folds are used for what function
- Modular proteins and protein modules

Structure of Folded proteins
- Topology
- Symmetry
- Multi-protein assemblies
- Geometry of proteins: packing, shape etc

Protein stability
- Inter- and intra-molecular interactions
- Hydrogen bonding geometry, aromatic interactions, pH dependence, dielectric properties of proteins
- The role of water, hydrophobic effect
- Thermodynamic signatures of folding
- Entropy/enthalpy compensation

Extremophiles
- Thermophiles
- Halofiles
- Alkalofiles
- Can we distinguish cause form consequence?

Hydrodynamic properties
- Protein as polymers
- Protein solubility
- Radius of gyration and other measures of dimensions
- Diffusion
- Rotation
- Electrophoretic mobility of single proteins and non-covalent complexes
- Chromatographic properties of single proteins and non-covalent complexes
- Sedimentation properties of single proteins and non-covalent complexes

Protein folding and aggregation
- Folding mechanisms
- Aggregation propensity
- Aggregation mechanisms

Ligand Binding
- Equilibrium processes
- Allostery
- Cooperativity
- Rates of association and dissociation

The relation between sequence and structure
- Secondary structure propensity
- Structure prediction
- Protein design

Protein dynamics
- Local and global fluctuations
- Time scales
- Connection to protein function

Membrane proteins
- Structural universe of membrane proteins
- Physical properties of membranes and its consequence for protein structure
- Membrane-spanning sequences
- Transporters and channels

Evolution
- Evolution of protein structure and function

Teaching
This is a reading course. For each session (every 14 days) the students get a literature list and a set of study questions. Each student reads the material and then they meet during ca. 2 h every 14 days to discuss the literature with help of the study questions. At the end of the discussion they call in the teacher to go through questions of their choice. Max 7 students per group and max two groups per course. The two groups meet separately, but at the end when they call in the teacher they all meet in one room.

Assessment
Assessment is based on an individual oral exam.

Grading scale
Possible grades are Pass and Fail. To pass the course, the student must pass the oral exam.

Language
The course is given in English.

Entry requirements
Completed course in physical chemistry, KFK032.