Poznań University of Medical Sciences

Department of Biophysics

60–780 Poznań, 6 Grunwaldzka Street
at Collegium Chemicum Building

BIOPHYSICS

A Guide for Students of 6-year Pharmacy Program 2016-2017

Course Coordinator: PhD Marek Tuliszka
phone no. 618-546-696
mail to: mtuliszka@ump.edu.pl

The Course of Biophysics

Fall Semester 2016/2017

1. Objectives

During laboratory classes students are expected to learn general rules of proper performance of laboratory experiments and general rules of measurements of direct and complex physical quantities. After a cycle of laboratory experiments students should be able to assess and estimate the accuracy of the results obtained. Student should be also provided with knowledge on how to present and interpret the obtained results.

Fundamental criterion of topic selection is the usefulness in teaching of pharmacy students on university level.
The introductory class is devoted to several aspects of laboratory measurements (units, statistical and graphical analysis of experimental data).

Laboratory topics comprise biophysical aspects of:

a) biological processes: diffusion across membranes, some aspects of creation and propagation of the action potential,
b) molecular interactions: electrochemical potentials, concept of viscosity, thin films (monomolecular layers), surface tension,
c) application of some technological devices in diagnostic and laboratory procedures – microscope, spectrophotometer, polarimeter.

2. Program

The course of Biophysics takes 30 hours. It is composed of 1 introductory seminar and of 11 laboratory classes.
The laboratory classes take place at the Department of Biophysics, 6 Grunwaldzka Street – at Collegium Chemicum building, according the schedule enclosed. Before the laboratory classes students are allocated to two-person teams in which they perform experiments.

Attendance at laboratory classes is obligatory. In case of non-attendance due to illness or other personal reasons, students are advised to make up for the missed classes following the coordinator's instructions.

Students are obliged to be on time. When coming more than 15 minutes late students are not allowed to take part in classes.

Students are expected to be well prepared theoretically on the basis of the material from the available laboratory textbook:
"Laboratory Exercises in Biophysics", edited by PhD Marek Tuliszka, Poznan University of Medical Sciences, Poznan 2008.
Supplementary reading: Douglas C. Giancoli, **Physics - principles with applications 7th edition**.

The enclosed list of problems the students should be acquainted with will be helpful in preparing to the laboratory classes.

Teacher:
PhD Marek Tuliszka

3. Evaluation system

Laboratory performance will be judged by the knowledge of the physical basis of the experimental methods and phenomena as well as written reports from performed experiments.

A student may obtain the grade points that range from 0 to 6 for each laboratory class. Therefore a maximal number of grade points is 66 ($11 \times 6 = 66$).

The knowledge of physical basis and applied methods will be judged by a 6-question test. During the test a student may get from 0 to 4 grade points. The successive points (from 0 to 2) may be gained from the laboratory report. A student who fails the test (less than three grade points) fails a laboratory class.

- Students who have attended all laboratory classes and the sum of the collected grade points is at least 49.5 (75% of the maximum number of grade points) do not need to take the integrative test and receive credit for the Course of Biophysics.

- Students who have attended all laboratory classes and the number of the collected grade points is less than 49.5 take an integrative test covering the material of all the laboratory classes. The test can be taken three times. The threshold for passing the test is the score of 60% of the possible maximum score.

- *A student who has either missed more than one laboratory class or failed all the integrative tests does not receive the credit for the Course of Biophysics.*

4. Information

Any questions, comments or suggestions regarding the course should be directed to PhD Marek Tuliszka, Department of Biophysics, 6 Grunwaldzka Street, room no. 131B.

THE LIST OF PROBLEMS FOR THE LABORATORY CLASSES

IMPORTANT: NUMBERS IN BRACKETS ARE THE NUMBERS OF CHAPTERS (!) IN THE ABOVE-MENTIONED LABORATORY TEXTBOOK: *Laboratory Exercises in Biophysics*; *G:* CHAPTER – CORRESPONDING PARAGRAPH IN DOUGLAS C. GIANCOLI, PHYSICS - PRINCIPLES WITH APPLICATIONS 7TH EDITION (ON-LINE VERSION)

1. Measurements (1)

The SI system of units. Discussion of errors of measurements. Sample calculus based on chosen examples: maximum and mean errors - idea of standard deviation, errors of combined quantities. Graphical representation of experimental results and experimental errors.

2. Spectrophotometry (2); *G: 24-7, 27-11, 28-10*

Absorption and emission of radiation: interaction of light with atoms and molecules. Luminescence: fluorescence and phosphorescence. Spectrophotometry: absorbance and transmittance. The Lambert and the Beer laws and their limitations. Estimation of unknown concentration of a solution by spectrophotometry.

3. Optical activity and polarimetry (3); *G: 24-10*

Polarized vs. nonpolarised light. Methods of polarisation of light. Optical activity. Specific rotation and optical purity. Principles of functioning of a polarimeter, Malus's law. Estimation of concentration of optically active compounds in solutions.

4. Attenuation of electromagnetic ionizing radiation (4); *G:27-3, 27-5, 27-6*

Mechanisms of attenuation of X- and gamma-radiation (photoelectric effect, Compton effected and electron -positron pair production), The Lambert law. The linear and mass attenuation coefficient. The half-value-layer and its determinations.

5. Viscosity (5); *G:10-11, 10-12*

The force of viscosity, shear stress and the rate of shear. The coefficient of viscosity η and its units. Viscosity of blood. Newton's principles of motion, the Archimedes principle and the Stokes force of viscosity. The Stokes method of estimation of a fluid viscosity.

6. Viscosity of solutions (6); *G:10-11, 10-12*

The coefficient of viscosity η and its units. The Einstein formula and relative viscosity. The specific and intrinsic viscosity. The Hagen-Poiseuille law. The Ubbelohde capillary viscometer. Estimation of the radius of a molecule by viscometric measurements.

7. Surface tension (7); *G:10-13*

Forces between molecules at a surface and in the bulk. Surface tension: definition and units.
Methods of determination of surface tension: the stalagmometer (drop count) method, and the capillary method. The Laplace law and basis of the bubble pressure method.

8. Monomolecular layer (8)

Surface tension. Amphiphilic nature of molecules. Structures formed by amphiphilic molecules in solutions. Surface pressure and surface pressure-area isotherms. Estimation of molecular dimensions by analysis of thin films parameters; molecular length and diameter.

9. Diffusion (9); *G: 13-14*

The phenomenon of diffusion. The Fick law. The diffusion coefficient and the factors which determine speed of diffusion, the Einstein-Smoluchowski equation. Membrane permeability and membrane permeability constant. Experimental determination of the diffusion coefficient and membrane permeability constant.

10. Electromotive force of concentration cell (10)

Electrode potential; the Nernst equation. Diffusion potential and the ion mobility; the Henderson equation. The concentration cell with transference and without transference. Electromotive forces of such cells; the Nernst equation for the EMF of concentration cell.

11. Action Potential (13); *G:18-10*

The structure of a neuron. Resting potential, mechanisms of transport of ions across a membrane. The Nernst and the Goldmann equation. Action potential. Depolarization and repolarization. Threshold of stimulation. Absolute and relative refractory period. Strength-duration curve, chronaxie and rheobase. Summation of synaptic inputs. "All or none" response.

12. Measurements of dimensions of small objects by microscope (20); ***G:25-5, 25-7***

Resolving power. Abbe's criterion and the Rayleigh criterion. Aperture, numerical aperture. Optical system of a microscope. Image forming - ray diagram. Magnification of a microscope. Calibration procedure of the microscope eyepiece. Determination of the dimensions of micro-objects (erythrocytes) by the microscope.

Schedule for the Laboratory Classes
Fall semester 2016/2017
Thursdays $17^{\underline{00}} – 18^{\underline{50}}$

TEAM	LABORATORY CLASSES - DATES												Integrative tests		
	13.10 2016	20.10 2016	27.10 2016	03.11 2016	10.11 2016	17.11 2016	24.11 2016	01.12 2016	08.12 2016	15.12 2016	12.01 2017	19.01 2017	26.01 2017	2.02 2017	9.02 2017
1, 2	1	2	3	4	5	6	7	8	9	10	11	12			
3, 4		3	4	5	6	7	8	9	10	11	12	2			

(**1**) Introduction to the problems of laboratory measurements – seminar (you need to be acquainted with chapter 1: “Measurements” from the laboratory textbook)
(**2**) Spectrophotometry
(**3**) Optical activity and polarimetry
(**4**) Attenuation of electromagnetic ionising radiation
(**5**) Viscosity
(**6**) Viscosity of solutions
(**7**) Surface tension
(**8**) Monomolecular layer
(**9**) Diffusion
(**10**) Electromotive force of concentration cell
(**11**) Action potential
(**12**) Measurements of dimensions of small objects by microscope