Practicals

M01. Introduction: Principles of physical measurements
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.
Tuliszka: Chapter 1 (p.7-29), Giancoli: Chapter 1 (p.1-18), Appendix A

M02. Estimation of molecular radius –viscosimetry and thin film method
Force of viscosity, shear stress and rate of shear. The coefficient of viscosity and its units. Viscosity of blood. Temperature effects on viscosity. Relative viscosity of solution - the Einstein's formula and its limitations. Specific viscosity, intrinsic viscosity and its determination. The Hagen-Poiseuille law. The Ubbelohde capillary viscometer. Estimation of the radius of a molecule by viscometric measurements.
Surface tension, surface energy, meniscus, the Laplace law, surface pressure, monomolecular layer, surfactants, amphiphilic properties of lipids, interaction of polar and non–polar groups with water; estimation of molecular dimension by analysis of thin film parameters
Tuliszka: Chapter 5 (p.55-60), Chapter 6 (p.61-65), Chapter 7 (pp.66-74), Chapter 8 (p.75-82), Giancoli: Chapter 4 (p.72-81), Chapter 10 (p.263-267) (p.274-276),Glaser: Chapter 2.5 (p.80-87) Chapter 2.4 (p. 45-48), Chapter 3.6 (p.204-210), Chapter 3.7 (p.223-225)

M03. Measurements of the diameter of an erythrocyte by microscope
Index of refraction. Snell's law. Image forming - ray diagram. Resolving power. Abbe's and Rayleigh's criteria. Numerical aperture and the aperture angle. Optical system of a microscope. Magnification of a microscope. Practical magnification. Calibration procedure of the microscope eypiece. Determination of the dimensions of micro-objects (erythrocytes) by the microscope.
Tuliszka, Chapter 20, Giancolli: Chapter 23 (p.623-663), Chapter 25(p.701-711)

M04. Electromotive force of concentration cell
Chemical and electrochemical potential. Electrode potential (the Nernst equation). EMF of the concentration cell without transference. Mobility of ions and diffusion potential (the Henderson equation). The concentration cell with transference versus the concentration cell without transference. Electrical conductivity, electrical resistance, The Ohm law, pH of solution
Tuliszka: Chapter 10 (p.91-96),Glaser: Chapter 3.1 (p.109-115), Chapter 3.2 (p. 141-146) Chapter 3.3-3.4 (p.163166)

M05. Action potential and formal neuron
The structure of a neuron. Resting potential, mechanisms of transport of ions across a membrane. The Nernst equation. 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.
Basic characteristics of real neuron functioning. Formal model of a neuron. Basic logic operators – negation, conjunction and alternative. Logic-logic functions. Arithmetic-logic functions. Neuron network, the side inhibition function, contour extraction.
Tuliszka: Chapter 13 (p.111-120),Chapter 14 (p.121-129), Giancoli: Chapter 18 (p.510-514), Glaser: Chapter 3.2 (p.141-143), Chapter 3.4 (p.167-181) Chapter 5.3 (p.330-333)

M06. Chronaxymetry
Qualitative and quantitative electrodiagnosis of nerves and muscles. Reaction of nerves and muscles to galvanic, faradic, rectangular and triangular currents. The Du Bois Reymond law. The Erb law of contraction. Galvanotonus. Strength-duration curve, determination of i/t cuve, the Hoorweg –Weiss equation. Motor point, accommodation coefficient and accommodation quotient Glaser: Chapter 4.4 (p.270-275), www. biofizyka.ump.edu.pl

M07. Diffusion and osmosis
Phenomenon of diffusion. Concentration gradient. The Fick law. Diffusion coefficient and factors which determine speed of diffusion. The Einstein-Smoluchowski equation. Semipermeable membrane versus selectively permeable membrane. Membrane permeability and its experimental determination. Osmosis, the van't Hoff law.

Tuliszka: Chapter 9 (p.83-90), Giancoli: Chapter 13 (p.376-378), Glaser: Chapter 2.3 (p.45-51) Chapter 3.2 (p.132-141), Chapter 3.3 (p.152-159)

M08. Interaction of light with matter
Spectrophotometry: Absorption and emission of radiation - energy level diagram. Luminescence: fluorescence and phosphorescence. Spectrophotometry: transmittance and absorbance. The Lambert-Beer law and its limitations. Analytical wavelength. Principles of functioning of the spectrophotometer. Estimation of unknown concentration of a solution by spectrophotometry.
Polarimetry: Polarized versus unpolarized light. Methods of polarization of light. Optical activity. Specific rotation and optical purity. The Malus law. Principles of functioning of the polarimeter. Estimation of unknown concentration of a solution by polarimetry.
Tuliszka: Chapter 2 (p.30-37), Chapter 3 (p.38-46), Giancoli: Chapter 22 (p.619-621), Chapter 28 (p.802-803), Chapter 24 (p.684-691), Glaser: Chapter 2.2 (p. 18-23)

M09. Attenuation of electromagnetic ionizing radiation
Generation of ionizing radiation. X-ray spectrum. Mechanisms of attenuation of X- and gamma-radiation (photoelectric effect, Compton effected and electron -positron pair production), The Lambert law. The half-valuelayer and its determination. The linear and mass attenuation coefficient and their determination.
Linear energy transfer(LET), detection of ionizing radiation, absorbed dose , exposition, biological effects of ionizing radiation, radioactive decay, decay law, half-life time.
Tuliszka: Chapter 4 (p.47-54), Giancoli: Chapter 27 (p.758-765), Chapter 30 (p.841-857)), Kane: Chapter 5 (p. 151-156), Chapter 7 (p.241-246), Kubisz: Chapter 3 (p.53-58, p.61-69, p 77-81), Glaser: Chapter 4.5 (p.275-277)

M10. Measurements of the conductivity of blood ~~conductivity~~
Electric current in metals and electrolytes. The Ohm law. Electric resistance and conductance versus electric resistivity and conductivity (definitions and units). Impedance of system with resistors and capacitors. Electric polarization and relaxation time of dipolar molecules. Electric properties of blood. Tissue in an external alternating electric field –dispersion of resistance and electric permittivity, tissue polarization coefficient. Hematocrit.
The Maxwell method for hematocrit determination. The scheme of AC current bridge. Tuliszka: Chapter 11 and 12 (p.97-110), Giancoli: Chapter 18 (p.493-502), Glaser: Chapter 3.5 (p.187-197)

M11. Examination of the behavior of non-stimulated muscle
Tension and load. Isometric and isotonic contraction. The stress relaxation process. The elongation relaxation process (creeping). The Hook law. The Young modulus. Rheological models of non-stimulated muscles (the Maxwell model, the Kelvin model and the St. Venant model). Viscoelastic properties of muscle. The force passive component of a muscle length.
Tuliszka: Chapter 16 (p.142-153), Giancoli: Chapter 6 (p.144-149), Chapter 9 (p.237-241), Glaser: Chapter 3.6 (p.210-215)

M12. Audiometry
Acoustic waves. Acoustic pressure amplitude. Physical attributes: wavelength, frequency , spectrum, amplitude and intensity of a mechanical wave. Physiological attributes: loudness, pitch, and timbre (color). The WeberFechner law - sound intensity level, decibel scale. Threshold of human hearing system. Loudness level – phone scale. Isophonic curves - Fletcher-Munson diagram, isophonic curves. Estimation of the threshold of hearing and equal-loudness curve. Audiogram.
Tuliszka: Chapter 18 (p.162-172), Giancoli: Chapter 11 (p.300-307), Chapter 12 (p.322-329) (p.334-335), Glaser: Chapter 4.3 (p. 240-251)

M13. Retinoscopy
Refraction and reflection of light. Optical power of lens. Focal length and focal point. Rules of finding the image by ray tracing for a converging and diverging lenses. Types of lenses(diverging, converging, stigmatic astigmatic). Thin lens equation, lens makers equation. Optical aberrations: chromatic aberration, spherical aberration and astigmatism.
Types of ammetropia: myopia, hyperopia astigmatism and correction of them. The near and far point of eye. Accommodation of eye. Refractive error. Principles of retinoscopy . Examination of an eye by retinoscopy.
Tuliszka: Chapter 17 (p.154-161), Giancoli: Chapter 23 (p.632-663), Chapter 25 (p.701-711)

Textbooks

1. . Laboratory exercises in biophysics M. Tuliszka (ed.) UMP, Poznań, 2008, ISBN: 978-83-7597-012-8(the laboratory textbook)
2. Elements of Medical Biophysics. Materials for seminars on biophysics, L. Kubisz, Wydawnictwo Naukowe Uniwersytetu Medycznego w Poznaniu, 2007, ISBN 978-83-60187-56-2
3. Biophysics, R.Glaser, Springer-Verlag, Berlin, Heidelberg, New York, 1999, ISBN 3-540-67088-2
4. Introduction to physics in modern medicine, Susan Amador Kane, Taylor & Francis, London, New York, 2003, ISBN 0-415-30171-8 (pbk), ISBN 0-415-29963-2 (hbk)