Minimum requirement of student's tasks for the acceptance of biophysics lab reports

Introduction (no lab report required)

Microscopy I. (number of graphs: 1)
Aims: To impart knowledge about the geometrical optics of a simple microscope; to measure the size of objects examined with a microscope and statistical analysis of the acquired data.
Tasks:

1. Calibrate the eyepiece scale of the microscope.
2. Measure the length of frog red blood cells.
3. Plot the frequency distribution of the cell length by using at least 50 individual measured data. *For this task, students should share their data in order to reach the minimum of 50 data points.*

Measurement techniques
Aims: To provide knowledge in the basic concept of measurements, to impart practical knowledge about the handling and basic properties of measuring devices by carrying out simple electronic measurements. To study the application of an oscilloscope for visualizing time-dependent signals.
Tasks:

1. Measurement of voltage, current and resistance with digital multimeter.
2. Measure the equivalent resistance in case of serial and parallel connection of resistors and verify Ohm's law.
3. Measure the parameters of a pure and a noisy sine function.

Refractometry (number of graphs: 1)
Aims: To study the basis of refraction and its special conditions, to determine concentration based on the measurement of refractive index.
Tasks:

1. Calibrate the refractometer with distilled water.
2. Determine the serum protein concentration based on the given calibration curve.
3. Plot the index of refraction vs. concentration graph of the given glycerol solutions. Determine the parameters of the calibration curve.
4. Calculate the concentration of a glycerol solution of unknown concentration.

Light emission
Aims: To grow familiarization with various types of light sources, emission spectroscopy and to impart knowledge about different spectroscopic tools.
Tasks:

1. Set the manual spectroscope and calibrate its scale.
2. Determine the wavelength of the lines seen in the emission spectra of various metal ion solutions.
3. Determine the composition of mixtures containing two metal ions based on their emission spectra (qualitative analysis).

Resonance (number of graphs: 2)
Aims: To verify Hook's law; to demonstrate resonance phenomenon, to determine the resonant frequency of an oscillating system and to demonstrate the dependence of the resonant frequency on the mass of the system.
Tasks:

1. Determine the spring constant of a cantilever by measuring and plotting the force vs. displacement data.
2. Plot the resonance curve of a cantilever.
3. Compare the measured and the calculated values of the resonant frequency.

Microscopy II (Special Microscopes)
Aims: To impart knowledge about the resolution limit of microscopes, to experimentally verify Abbe's principle and to familiarize with the working principle of some special microscopes.
Tasks:

1. Determine the grating spacing of an optical grating by using a coherent source of light with known wavelength.
2. After knowing the grating constant, determine the wavelength of another light source with unknown wavelength.

Light absorption (number of graphs: 2)
Aims: To impart hands on experience in absorption spectrophotometry, to reveal the method of spectrophotometric titration and concentration determination.
Tasks:

1. Measure the absorbance of the copper-complex solution at different wavelengths, plot the absorption spectrum and determine the excitation energy at the wavelength of maximal absorption (in eV units).
2. Measure the absorbance of the given complex solutions at the wavelength of maximal absorption and plot the results as a function of ligand concentration.
3. Determine the copper concentration by using the parameters of the two fitted lines.

Optics of the eye
Aims: To describe the image formation of human eye and its common refractive errors based on optical geometry. To determine some important and interesting parameters of the eye.
Tasks:

1. Determine the personal power of accommodation.
2. Determine the personal visual acuity (visus) and estimate the receptor density in the *fovea centralis* based on the best visual acuity of your group.
3. Determine the personal blind spot size and its distance from the yellow spot.

Nuclear medicine (number of graphs/curves: 2/3)
Aims: To impart knowledge about the parts and operation of the scintillation counter; to clarify the terms: signal and noise, to determine the optimum setting of the instrument.
Tasks:

1. Check the preset parameters of the scintillation counter, adjust if necessary.
2. Measure and plot the pulse number as a function of integral discriminator level with and without the sample isotope.
3. Plot the signal-to-noise ratio vs. the integral discriminator voltage and determine the value of optimal integral discriminator level.

Polarimetry
Aims: Introduction to different kinds of polarized light and to optically active materials; to investigate optical rotation and to carry out qualitative and quantitative examinations by measuring the angle of optical rotation.
Tasks:

1. To determine the specific rotation of an unknown sugar solution with known concentration.
2. Determine the type of sugar based on the specific rotation.
3. To determine the concentration of solution prepared from a known sugar.

Skin impedance (number of graphs: 1)
Aims: To reveal the importance of impedance in relation with the hazards of electric current and contact protection; to familiarize with medical diagnostic methods based on impedance measurement.
Tasks:

1. Measure voltage and current at various AC frequencies (also DC), in a circuit that is wired through your skin.
2. Plot the impedance as a function of frequency.
3. Determine the specific resistance and specific capacitance of skin.

Gamma absorption (number of graphs/curves: 1/4)
Aims: To investigate the gamma radiation absorbing capacity of various materials, in regards with radiation protection.
Tasks:

1. After checking the parameters of the scintillation counter, measure the pulse number in case of various absorbers (correct your data for the background).
2. Create a comparative plot of the pulse number values measured for different materials as a function of the absorber thickness (attenuation law).
3. Determine and compare the half-value thicknesses, attenuation coefficients and mass attenuation coefficients for each absorber material.
4. By using the appropriate graph determine the energy of the gamma photon emitted by the isotope and the partial mass attenuation coefficient for photo- and Compton effects respectively.

Repetition (no lab report required)