

Syllabus
of the Biophysics course at the Faculty of Veterinary Sciences,
Szent István University, Budapest

Semester 1

Introduction

2 hours

Result of a measurement, standards, units and errors, systematic and random errors, the average and the standard deviation, error of radioactive counts, error propagation, the fundamental physical quantities, the SI system

Macrotransport processes

6 hours

Density and pressure, buoyant force, Archimedes' principle, flow of fluids, equation of continuity, streamline flow, Bernoulli's law, the manometer, measurement of blood pressure by cannulation, the static and dynamic consequences of the Bernoulli's law, the Venturi tube

Flow of viscous fluids, Newton's friction law, viscosity, Newtonian fluids, laminar flow, the parabolic velocity profile, the Poiseuille' law, turbulent flow, the Reynolds number, measurement of the blood pressure, the concept of flow resistance, flow resistance of parallel and serial tubes,

Viscous drag forces, Stokes law, flow in the circulatory system, the terminal velocity of a small particle falling in a viscous fluid, measurement of viscosity,

Flow in the circulatory system, transmural pressure, the law of Laplace, energetics of the circulatory system, the heart as a pump, work done by the heart, flow in tubes of elastic wall, non-Newtonian fluids

Microtransport processes

4 hours

Diffusion, Fick's first and second law, time course of simple diffusion, diffusion across the alveolo-capillary membrane, osmosis, Van't Hoff's law, iso-, hypo-, and hypertonic solutions, measurement of osmotic pressure

Transport across the cell membrane, the structure of the cell membrane, passive diffusion, membrane permeability, determination of the permeability from the change of concentration difference in time, correlation between the membrane permeability and the lipid solubility, properties and mechanisms of the facilitated diffusion, active transport

Sedimentation, ultracentrifugation, the velocity of sedimentation, the sedimentation coefficient, determination of molecular mass by sedimentation-diffusion and sedimentation equilibrium methods, density gradient centrifugation

Physics and applications of light

6 hours

Basic principles of geometric optics, the concept of light ray, reflection and refraction, index of refraction, Snell's law, total reflection, Slab with parallel surfaces, prism, dispersion of light

Optical image formation, thin spherical lenses, lensmaker's equation, image formation by lenses, the ray-tracing method, thin lens equation, the power of a lens, combination of thin lenses, lens aberrations, thick lenses, ray-tracing for thick lenses, spherical mirrors, the Fermat principle

The structure of the human eye, refraction of light travelling across the eye, the far and near points, accommodation, visual acuity, sensitivity, colour perception, optical defects of vision

Optical devices, simple magnifier, structure and image formation of a compound microscope

Semester 2

Physical optics

6 hours

The wave nature of light, the electromagnetic spectrum, Huygens' principle
Light interference, Huygens-Fresnel' principle, conditions of reinforcement and weakening, coherence, Fresnel's double mirror, the diffraction grating
Light diffraction by narrow slit and by circular aperture
Resolving power of optical devices, Rayleigh's and Abbe's criterions
Types of light microscopes,
Electron microscopy, transmission and scanning electron microscopes
Polarization of light., Brewster's law, birefringence, Nicol prism.
The optical activity and its measurement, optical rotatory dispersion, circular dichroism

Photometry

6 hours

Photometric quantities, visual photometry, radiometry,
Photoelectric effect, the photoelectric Einstein equation, the photoelectron multiplier
Interaction of light with matter, emission, scattering, absorption, the law of light attenuation
Luminescence, spectrophotometry, spectrofluorimetry,
Optical spectrometry, flame photometry, resonance absorption, atomic absorption spectroscopy
Light sources: thermal radiators, luminescence light sources, principle and properties of lasers
Production of X-rays, the X-ray spectrum, bremsstrahlung and characteristic X-rays, attenuation of X-rays in matter
The biological effects of light

Electricity

8 hours

Passive electric properties of living substances, resistance and capacitance of the axon, harmful physiological effect of electric currents
Active electric properties of living matter, excitability, resting potential of cells, Donnan potential, Goldman equation, the Na-K pump, changing of the resting potential, response to a weak stimulus, the action potential and its propagation
Measurement of the membrane potential, electric measurements, voltage clamp technique, patch-clamp technique, optical measurements
Body surface biopotentials, ECG, EEG, ERG, structure and operation of cathode-ray oscilloscope
Medical applications of electricity, basic concepts of signal, noise, decibel, transfer characteristics, high frequency electric diathermy, effect of low frequency electricity, galvanic skin response

Elements of nuclear physics and radiation

4 hours

Radioactivity, the Rutherford experiment, structure and stability of the nucleus, nuclear forces, properties of radioactive decay, biological half life, radiocarbon dating, activation analysis, chain reactions
Biological effects of nuclear radiations, radiation units, activity, exposure and absorbed dose, radiation detectors
In vitro and in vivo medical applications of radioactive isotopes, the tracer method, radioimmunoanalysis
The biological effects of ionizing radiations, target theories, water activation, surviving curves

Sound, ultrasound

2 hours

Origin and propagation of sound, properties and sensation of sound, Weber-Fechner law, Stevens law, Doppler effect
Ultrasound, the effects and diagnostic use of ultrasound

Imaging methods in medicine

2 hours

Conventional linear and axial tomography, computer tomography, image formation using radioisotopes, the gamma camera, positron emission tomography, NMR imaging

Thermal Physics

2 hours

Temperature and its measurement, thermography and its medical applications
Body temperature and its limits, forms of heat loss from the body, heat radiation, Wien's law, Stefan's law, conduction, convection, evaporation, respiration and excretion
Temperature regulation in homeothermic organisms

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Prof. Zoltán Szőkefalvi-Nagy
invited lecturer