МЕДИЦИНСКИ УНИВЕРСИТЕТ-СОФИЯ
МЕДИЦИНСКИ ФАКУЛТЕТ
КАТЕДРА МЕДИЦИНСКА ФИЗИКА И БИОФИЗИКА
Ул. Здраве №2, София-1431

SYNOPSIS
of MEDICAL PHYSICS for students in DENTAL MEDICINE
Academic year 2013/2014

1. **Structure of liquids**
   Molecular structure of bodies. Surface tension of liquids, coefficient of surface tension, molecular pressure. Trickling. Wetting, non-wetting, meniscus, capillary phenomena, LaPlace pressure. Gas embolism. Water – structure, properties and importance for living organisms.
2. **Structure of solids**
   Amorphous, crystalline and liquid crystalline states. Mechanical deformations, Hooke's law. Strength and hardness of materials, scale of Mohs. Method of Brinell.
3. **Hydrostatics. Effect of pressure on human organism**
   Basic concepts: density, ideal and real fluids, hydrostatic pressure. Archimedes force, atmospheric pressure. Effect of pressure on human organism.
4. **Hydrodynamics – medical applications**
   Continuity equation and Bernoulli's equation. Laminar and turbulent flow, Reynolds number. Measurement of blood pressure. Newton's law for inner friction. Poiseulle's law, viscosimetry. Infusion and inhalation. Non-Newtonian behaviour and microrheological processes.
5. **Phase separation in liquid heterogeneous systems**
   Uniform circular motion, centripetal acceleration and force, centrifugal force. Sedimentation and centrifugation. Sedimentation velocity, centrifugation, types of centrifuges. Inertial force effect on human organism, overloading, weightlessness.
6. **Sound**
   Mechanical oscillations and waves, period, frequency, wavelength. Harmonic oscillation equation. Equation of mechanical wave propagation, transverse and longitudinal waves. Diffraction and interference. Sound. Physical characteristics of sound. Extracorporeal shock-wave lithotripsy.
7. **Psychophysical characteristics of sound**
   Psychophysical parameters of sound, range of hearing, audiometry. Frequency resolution, binaural effect. Physics of vocal apparatus of humans. Acoustic methods in medical diagnostics. Noise protection.
8. **Ultrasound**
   Properties of ultrasound. Piezoeffect and reverse piezoeffect. Physical principles of echography. Effect of Doppler and Doppler sonography. Medical applications of ultrasound.
9. **Temperature and heat**
   Temperature scales. Heat expansion of bodies. Volume expansion. Thermal properties of water. Specific heat, calorimetry. Thermostats, thermoregulators, sterilizers.
10. **Thermal exchange, laws**
    Thermal exchange by thermal conductivity, convection, radiation and absorption. Kirchoff's law of thermal radiation, Stefan-Boltzmann law, Wien's law.
11. **Electric field**
    Intensity and potential of point chatge and electric dipole in vacuum. Electric field in material medium. Orientational and induced polarization. Electric capacity of a conductor and a flat capacitor.

12. **Electrical conductivity**
    Electrical conductivity of solids and liquids. Electrolytic dissociation. Solvation (hydration) and recombination of ions. Degree of electrolytic dissociation. Conductivity of electrolytes. Faraday's law. Direct and alternating electric current.
13. **Magnetic field**
    Magnetic field of a permanent magnet. Magnetic field of direct current. Ampere's law – magnetic induction. Magnetic field of electric current in circular conductor, solenoid. Charge motion in magnetic and electric fields – Lorentz force. Mass spectrometry.
14. **Magnetic properties of substances**
    Magnetic field intensity, magnetic permeability. Dia-, para-, and ferromagnets, magnetic hysteresis. Mechanical and magnetic moments of electrons and atoms. Electron paramagnetic resonance. Magnetic nanoparticles for diagnostics and therapy.
15. **Physical basis of electrodiagnostics**
    Electrography, heart as an electric dipole. Linear electrocardiogram (ECG), triangle of Einthoven. Electrostimulation, types of electric pulses, parameters. Rheobase and chronaxie.
16. **Physical basis of electrotherapy**
    Electrotherapy with direct, low-frequency and mid-frequency currents. Electrotherapy with high- and ultra high-frequency currents. Defibrillators and electronic pacemakers. Drug electrophoresis. Electrical safety.
17. **Ultraviolet, visible and infrared radiation**
    Electromagnetic waves. Electromagnetic spectrum. Sun radiation. Spectral sensitivity of human eye. Photometric quantities and units. Properties of ultraviolet and infrared radiation – importance for the biosphere. Infrared thermography.
18. **Reflection and refraction of light**
    Snell's law. Total internal reflection, conditions for total internal reflection. Fiber optics. Endoscopes. Refractometry.
19. **Scattering and absorption of light**
    Scattering of light in turbid media, Tyndall effect. Rayleigh law. Nephelometry. Absorption of light, Beer–Lambert–Bouguer law. Photocolorimetry. Normal and anomalous dispersion.
20. **Polarization of light**
    Natural and polarized light, Malus's law. Obtaining linearly polarized light, polarization prisms and polaroids. Brewster's law. Birefringence, linear dichroism. Rotation of polarization plane, polarimetry.
21. **Optical lenses**
    Basic elements of spherical lenses. Optical power of lenses. Image formation by spherical lens. Centered optical system. Aberrations of optical lenses. Astigmatism, cylindrical lenses. Prismatic glasses.
22. **Human eye as an optical system**
    Physics characteristics of human eye. Accomodation. Spherical aberration of human eye. Myopia and hyperopia, correction with lenses, correction by laser ablation. Correction of astigmatism and strabismus.
23. **Optical microscope**
    Principal diagram, optical scheme, microscope magnification. Resolution, numerical aperture, useful magnification of optical microscope. Immersion objective. Methods of microscopic observation. Polarizing and fluorescence microscopes.
24. **Electron microscope**
    Principles of corpuscular microscopy – de Broglie waves. Transmission and scanning electron microscopes – principal diagrams and image formation. Preparation of biological samples for electron microscopy.
25. **Nuclear magnetic resonance (NMR)**
    Nucleus composition, charge, mass and spin. Magnetic moments of nucleons and nucleus. Nuclear magnetic resonance – conditions of appearance. Medical applications.
26. **Atomic spectra**
    Atomic energy levels, Pauli principle, optical transitions between energy levels. Atomic spectral analysis; emission, absorption and fluorescence analysis.

27. Molecular spectra
Energy levels and transitions in molecules. Molecular spectral analysis, types of. Spectrophotometry.

28. Luminescence
Types of luminescence, laws of Stokes and Vavilov in photoluminescence. Fluorimetry, biochemiluminescence.

29. Lasers
Spontaneous transitions, induced emission. Normal and inverse energy level population. Main components and principle of operation of a laser. Laser types. Properties of laser radiation. Applications of lasers in medicine and dental medicine.

30. Radioactivity
Radioactivity, radionuclides. Alpha- and beta-nuclear transformations, energy spectra. Gamma-radiation, spectra. Metastable state, isomeric transition.

31. Activity of radioactive sources
Law of radioactive transformation, radionuclide half-life. Biological half-life, effective half-life. Radiometric analysis, method of isotope dilution. Radiopharmaceuticals, method of preparation, application. Neutron-activation analysis.

32. Radionuclide diagnostics
Scintillation detectors. Linear scanner and gamma-camera, principle of operation. Single-photon emission computer tomography. Positron-emission tomography, diagnostic potential.

33. X-ray (Roentgen ray) radiation
Principle of operation of X-ray tubes. Bremsstrahlung and characteristic X-ray radiation. Intensity and spectrum of X-rays, graph. Properties of X-rays.

34. X-ray diagnostics
Principle of X-ray diagnostics. X-ray diagnostic methods. X-ray computer tomography.

35. Interaction of photon ionizing radiation with matter
Photoelectric absorption, Compton scattering, electron-positron pair production. Intensity attenuation law. General linear attenuation coefficient. X-ray and gamma-radiation therapy.

36. Interaction of charged particles with matter
Braking ability, linear ionization, mean linear pathway, mean free pathway. Elastic scattering, inelastic interaction processes.

37. Effect of ionizing radiation on human organism. Dosimetry quantities
Natural and technogenic sources of ionizing radiation. Externak and internal irradiation. Dose, power of dose, exposure, conversion factor, equivalent dose, radiation weight coefficient, effective dose, tissue weight coefficient.

Supplements:
1. Lecture notes

Department chair:

(professor B. Tenchov)