SHORT COMMUNICATION

Project support of practical training in biophysics

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Abstract

The Department of Biophysics ensures practical training in biophysics and related subjects for students of medical and health study programmes. Demonstrations of medical technology are an important part of this training. Teaching for Faculty of Sciences in biophysical study programmes becomes also very important. Some lectures and demonstrations of technology are involved, but the practical trainig is missing.

About 1 mil. CZK for additional laboratory equipment was obtained from the HEIDF project No. 1866/2005 "The demonstration and measuring technology for education in medical biophysics and radiological physics" for measuring system DEWETRON for high frequency signal analysis, Fluke Ti30 IR camera, PM 9000B patient monitor, ARSENAL AF 1 fluorescence microscope, and Nikon Coolpix 4500 digital camera with accessories for microphotography.

At the present time, further financial resources are being provided by a development project of Ministry of Education "Inter-university co-operation in biomedical technology and engineering using top technologies" in total amount of almost 5 mil CZK, whereas over 2 mil CZK from this project are reserved for student laboratory equipment. The main goal of this project is to ensure the participation of Medical Faculty in educational co-operation in the biomedical technology and engineering, namely with the Faculty of Electrical Engineering and Communication (FEEC), Brno University of Technology. There will be taught those areas of biophysics which are not covered by FEEC, thus forming a separate subject "General Biophysics". The following instruments will be installed: UV-VIS spectrophotometers, rotation viscometers, tensiometers, microscopes with digital image processing, cooled centrifuge, optical benches, and some smaller instruments for practical measurements.

Key words: practical training in biophysics, biomedical technology.

The Department of Biophysics, Medical Faculty, Masaryk University, Brno, Czech Republic, ensures practical training in medical biophysics and related subjects (biophysics for bachelor study programes) for about 600 students of medical and health study programmes every year. Demonstrations of selected medical technology are an important part of this training with total extent of about four hours for each study group.

There are also some other important reasons for implementation of new tasks in the practical exercises. Teaching for Faculty of Sciences in biophysical study programmes becomes very important. Some lectures and demonstrations of technology are already involved in this activity, but the practical training is still missing. We expect to start with practical exercises for Faculty of Science in the second semester 2006/2007. We can also expect that new study programes will be started: the "Radiological technician" and "Radiological physicist" after finishing accreditation process. In these programmes, the biophysical training is also involved. More recently, in co-operation with the Faculty of Electrical Engineering and Communication (FEEC), Brno University of Technology, parts of biophysics will be taught which are not covered by FEEC, thus forming a separate subject "General Biophysics".

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Laboratory equipment necessary for practical exercises is relatively expensive and should be renewed regularly to remain in sufficient contact with progressing medical technology. There is almost no other way to fulfil this condition exploiting only internal faculty resources. We have to seek for additional financial support.

Resources obtained from HEIDF and their application

During 2005, about 1 mil. CZK was obtained and spent for modern laboratory equipment from the Higher Education Institutions Development Fund (HEIDF, FRVŠ in Czech) project No. 1866/2005 "The demonstration and measuring technology for education in medical biophysics and radiological physics". Following devices and instruments were put in operation:

– Measuring system DEWETRON for high frequency signal analysis. The students will get acquainted how to use a PC as a measuring system. It involves a PC with a developer's environment software LabView, a multi-functional card National Instruments PCI-6024E and an osciloscopic card PCI-5112. The training will be focussed on measuring systems in general, data acquisition, analysis and presentation, application principles of the developer's environment – creating of the virtual measuring systems etc.

– Fluke Ti30 IR camera. The instrument allows taking thermograms and recording radiometric values from a short or long distance. It has a memory for up to 100 images, which can be transferred into a PC and processed then by InsideIR software. The system involves also a notebook (with InsideIR installed) and a data projector serving for projection of images to whole study groups. Measurement records can be printed or exported in digital form. The camera can measure temperatures from -10 to +250 °C with absolute accuracy +2 °C, but the display is sensitive enough to distinguish temperature differences of 0.1 °C. There are different operation modes possible and three colour scales can be used. The object measured or depicted can be targeted by built-in laser pointer. When needed, this apparatus can be used also by other faculty (university) facilities, as well as, in fire prevention, thermal insulation control in new university campus buildings etc., because it is the only camera of this kind in the whole University.

– PM 9000B patient monitor. It is a device serving for monitoring of vital functions – EKG, oxygen saturation of arterial blood, breathing, blood pressure and temperature. For the recording of EKG curves, three chest leads are used, and always one lead is possible to observe on the monitor. For the measurement of blood pressure, an automatically inflatable cuff is available, and the values of systolic, diastolic and mean blood pressure are displayed. The measurement of blood oxygen saturation is done by a photometric sensor placed on a finger. In the upper part of the screen, pulse rate is displayed. The readings and the EKG curves can be printed in real time or "frozen" for evaluation.

– ARSENAL AF 1 fluorescence microscope. This instrument will be used in demonstration lessons (which are a regular part of practical exercises) as an example of a device used in biophysical research on cellular level. The microscope is already at disposal for students doing diploma or doctoral theses. It can be characterised as a standard laboratory microscope equipped, among others, by a revolving binocular head with adjustable magnification and a head for microphotography, a phase contrast, many filters, epifluorescence illumination provided by a mercury lamp with continuously adjustable light intensity.

– Nikon Coolpix 4500 digital camera with accessories for microphotography. This camera can be connected to the fluorescence microscope. The digitised images can be processed by IMPOR EDUCA software, and, consequently by more sophisticated image processing software tools. The camera can be utilised also for taking pictures for other educational purposes etc.

Resources obtained from Development projects and their application

At the present time, further financial resources are being provided by a Development project of Ministry of Education, Youth and Sports: "Inter-university co-operation in biomedical technology and engineering using top technologies". The total extent of these resources is almost 5 million CZK, whereas over 2 million CZK are reserved for our student laboratory equipment. The main goal of this project is to ensure the participation of Medical Faculty in educational co-operation in the biomedical technology and engineering, namely with the Faculty of Electrical Engineering and Communication (FEEC), Brno University of Technology. In our Department, those areas of biophysics will be taught, which are not covered by FEEC, thus forming a separate subject "General Biophysics". The following devices or instruments will be installed in the laboratory:

– A) Spectrophotometer Boeco S-22 UV/VIS with wavelength range of 198–1000 nm, spectral bandwidth of 6 nm, and a xenon lamp as a light source. B) Spectrophotometer UV/VIS Spectronic Genesys, with wavelength range of 190–1100 nm, split-beam system, spectral bandwidth of 1.8 nm, and a xenon lamp. The apparatus can be used on-line with a PC. Both apparatuses will replace older Specols (East German products), which cannot be used for measurement in UV-range. Therefore, e.g. spectroscopic measurements of biopolymers can be performed now.

– Rotation viscometers (2) Visco Star Plus L with an adapter for measurements of low-viscosity liquids (from 1 to 2,000,000 cP). The sample temperature is also displayed. Minimum volume measured is 20 ml. These instruments will be an alternative to capillary Ostwald viscometer.

– Tensiometers: A) Transportable bubble tensiometer PocketDyne. It serves for dynamic measurement of surface tension, and is equipped with PC interface. The measurement can be done in the range of 10 to 200 mN/m with resolution power of 0.1 mN/m. B) Digital tensiometer Krüss K9 for the measurement of surface and interface tension with PC interface and control software. The measured sample is placed in a thermostated housing with a built-in stirrer. Movement of the platinum frame is controlled by PC, i.e. fully reproducible. It measures in the frequency range of 1 to 1000 mN/m with resolution of 0.1 mN/m.

– Two student microscopes Olympus CX21 with digital image processing, equipped with a planachromatic objective (magnification 4, 10, 40 and 100), halogen bulb, trinocular head, a videoadapter and a 8Mpix digital kamera. It involves also a notebook with image processing software. The microscopes will replace partly the old optical microscopes allowing substantial improvement and broadening of respective practical tasks.

– Cooled centrifuge MPW 350RS with rotors type Angle HSL 24x2.2/1.5 ml a 12x10 ml. It reaches 18 000 rpm with the first rotor and 15 000 rpm with the second one. The temperature can be adjusted to values from about -20 to +40 °C. This device will be used for purification of macromolecular samples.

– Several items with price below investment limit will be also purchased: PCs, printers, laboratory glass and aids, as well as smaller or low-cost apparatuses – for example, a bidirectional vascular Doppler Smartdop (4MHz probe) equipped with a thermal printer for depiction of the forward and backward velocity curves. To have a possibility of recording the EKG curves under defined physical load, Kettler EX1 programmable bicycle ergometer was already purchased.

In 2005, we also took a part in a Development Project of Ministry of Education, Youth and Sports oriented on future education of radiological technicians and physicists (an equivalent of medical physicists in most European countries). The apparatuses purchased (for about 1 million of CZK) are necessary for their special training, but it is also possible to use them for demonstrations of special dosimetric technology in basic biophysical courses.

– Monitor RADCAL 9010 with ionisation chamber 10X5-1800 for the measurement of X-ray beams (in general radiology, mammography, CT, fluoroscopy) and gamma radiation beams. Dose and dose rate can be measured in impulse or continuous mode.

– Monitor RADCAL 9095 with ionisation chamber 10X9-6 for the measurement of dose absorbed in the air, dose rate, cathode voltage and duration of the voltage impulse.

– Universal dosimeter UNIDOS with a reference strontium source, ionisation chamber TM 30012, and the water phantom type 41001. It can be used for measurement of dose and dose rate in radiotherapy, diagnostics and radiation protection, as well as, for calibration of horizontal therapeutic beams.

Internal faculty resources

Internal faculty resources reveal themselves to be additional but very important means for further improvement of student laboratory equipment. They allow to purchase items with price up to several hundreds thousands CZK every year. For example:

– (2003) two diagnostic audiometers AD 226 Interacoustics for hearing threshold determination,

– (2004) digital sonograph Sonoace 5500 Medison for demonstration of a modern B-mode ultrasound,

– (2005) a therapeutic ultrasound unit Beautyline-07 for practical task for ultrasound evoked haemolysis,

– (2006) PhyWe X-ray student laboratory apparatus (cathode voltage up to 35 kV) which will be unique in the whole University.

Conclusions

There is no doubt that there will be always a need to do also very transparent and simple experiments in practical lessons, which do not require any complex technology. However, there are also reasons to measure with or demonstrate more sophisticated and automated devices. Some of them can motivate the students for steady interest in biomedical technology applications in clinical branches of medicine. The main purpose of this article is to demonstrate that, under condition of relentless effort to search for financial resources, it is possible to keep up with technology progress in medicine and biosciences even in pregraduate education.

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