A survey of biomedical technology in research carried out at the universities of the Netherlands and by the organisation for applied scientific research (TNO)

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INTRODUCTION

The term biomedical technology (BMT) is understood as all the activities by means of which scientific and technical knowledge and skills are applied to problems in health care and biology.

Research in this field has received considerable attention for many years at the universities both traditional and technological, as well as at the Medical Technology Department (MTD, developed out of the Medico-Physical Institute of the Organisation for Applied Scientific Research (TNO)). For this field of research an organisation was created with the name Inter-University Biomedical Technology Committee (IUO), known as IUO-BMT. The work of the committee is oriented to cooperation where this is considered to be useful and feasible.

The medical faculties of the universities carry out programmes of research which are directed towards medical problems. In many cases BMT elements comprise a considerable part of such problems. The description of BMT given above corresponds in part to what is generally understood by physiological research. The name BMT is related to concepts such as biophysics, clinical chemistry, clinical physics and medical physics.

All these concepts have in common that they concern activities with multidisciplinary aspects referring to health care and biology as object areas of this kind of research. By BMT is here mainly understood those activities in which a certain technology predominates. This is so in the following cases:
- where new technological developments can create new possibilities for medico-biological research,
- where the research is largely determined by difficult experimental facilities from the technological standpoint,
- where the application of new fundamental knowledge to diagnostics, therapy, rehabilitation or prevention, require technological developments in the form of new equipment, methods, systems or processes.

In a number of groups a growing integration of BMT can be observed in the research programmes. Often we encounter a growth in the direction of multidisciplinary cooperation at the institute level. IUO-BMT sees its role, among other things, as stimulating the interchange of specific BMT knowledge and skills between the institutions contributing to the progress of research in the fields of interest.

With this aim in view the present report gives a summary picture of the main characteristics of the BMT elements in the research programmes at the universities and MTD (TNO). For those who require more detailed information a list of contact persons per institute is attached.
IUO-BMT also directs its attention to general aspects of BMT. Some of the things which come under this heading are the following:

- Medical Technology Assessment.
- Industrial use of products of (BMT) research.
- Safety aspects of clinical equipment in general.
- Ergonomic aspects as regards patients, medical and paramedical professional groups.
- Teaching situation touching on BMT aspects.
- Maintenance of adequate marginal conditions to ensure the natural developments of BMT.
- Promotion of financing facilities for this multidisciplinary field of research within the predominantly monodisciplinary structure of the research financing system.

This survey deals with aspects of BMT which are usually part of larger research programmes. Hence no conclusions with regard to these wider research frameworks can be drawn from the present survey.

The BMT information per institution is given in the form of brief descriptions. In so doing, the recognisability within each institution is retained as far as possible. Variations occur in the volume of the research per point of reference. Likewise the bundling of the various points, determined by the local situation, does not always take the very same form everywhere.

The characterisations of the BMT elements per institution came into being in consultation with the members of IUO-BMT. Of course personal views played a role here and there. The aim of giving some uniformity to the survey led the editorial board to make some adjustments. For that reason the institutes taking part in the consultation cannot be held responsible for the contents of the present report. Such responsibility rests with IUO-BMT.

The BMT elements included in the present survey are, as a rule, part of long-term areas of research activity. It is in part for such reasons that the attempt has been made to give a picture of BMT that can be functional up to the end of the eighties of the present century.
2.1 Diagnosis of ischemic cardiac diseases with the aid of ultrasound

- Development of transducers and systems and their application in diagnostics and cardiological research
- Quantification and automatic acquisition and processing of echocardiographic data
- Development of methods of measurement for the recognition of tissue types

2.2 Development of automatic ECG analysis, contractility measurements and image processing

- Automatic processing of one-dimensional and two-dimensional signals
- Improving and automating diagnostic methods for clinical systems: ECG with the patient at rest, ECG with the patient under stress, Holter ECG, cardiac catheterisation, coronary angiography, angiography of the left ventricle, scintigraphy
- Methods and systems for intensive surveillance of the patient

2.3 Lung function parameters

- Development of quantitative models for interpretation of plethysmographic measurements carried out on a patient's body
- Improvement of the thermodilution measuring method for cardiac output during artificial respiration

2.4 Rehabilitation research

- Parameter studies of posture and movement patterns
- Development of systems for determining forces and movements
- Dynamometry, in particular, isokinetic measurement for the evaluation of therapy, among other things
- Research into the choice of technical facilities in the rehabilitation process

2.5 Electrogastrography

- Measurement of myoelectrical activity of the smooth muscular tissue of the stomach with the aid of electrodes on the skin of the abdomen (dog and man) for the study of normal and anomalous mobility of the stomach and gut
2. Design and construction of radio-telemetry systems, implantable in test animals: single or multichannel, for recording of physiological parameters

2.6 Prevention of injuries of the musculoskeletal system

- Continuous measurement of parameters concerning posture and movement without hindrance to the worker
- Laying down design criteria for workplaces and the quantification of the human factors based on biomechanical studies of sitting and standing work
- Research into the system comprising the foot and footwear as a whole; identification of the relevant physical parameters and the development of equipment for quantifying same
3.1. Bioelectricity

- Recording and analysis of changing potential distributions over the surface of the body. Modelling of the activation trends of the cells of the cardiac muscle (Body Surface Mapping)
- Quantification and analysis of electrical nerve fibre signals for the purpose of clinical diagnostics
- Electrophysiological signal processing of muscular activity; development of single-fibre diagnostics in muscle-nerve diseases
- Research on and application of estimating methods for evoked potentials
- Chronotopography: measurement of changes in potential across the cerebral cortex after somato-sensible stimulation

3.2 Data analysis

- Matfun: universal software package for signal processing with extensive graphic facilities; accessible to scientists with or without experience in computer programming; flexibly applicable in new research
- Analysis of nerve fibre and muscle signals (single fibre, motor unit, muscle as a whole)
- Research on perception of brightness of the normal temporal and spatial changes in stimulus with the aid of stabilisation techniques
- Development of visual evoked potential (VEP) measuring techniques; improvement of the signal-to-noise ratio, development of recursive, time-variant filtering methods
- Optimisation of X-ray research with the aid of psychophysical methods
- Measuring and interpreting visually guided movements of the eye under normal and pathological conditions
- Quantitative processing of the foetal heart frequency and intra-uterine pressure with the aid of international standards
- Recording and correlation of vital parameters in the case of newly born sick children, obtained in a non-invasive manner
- Analysis of visual quality of medical diagnostic images
- Pattern recognition of cell preparations in pathological anatomy
- Tissue differentiation by means of ultrasound (acoustospectrography); processing and analysis of clinical echograms

3.3 Radiology

- Dosimetry in X-ray examinations; radiation reduction in thoracic exposures
- Modelling of electron bundles, calculation of isodose patterns in clinical applications
3.4  
**Biomechanics**

- Mechanics of joints; knee and wrist
- Implants in joints; designs, calculations of stress, fixation methods, design and selection of criteria
- Materials for use in dentistry

3.5  
**Mass spectrometry**

- New diagnostics using skin and hair
4.1 Electrophysiology, mechanics and biochemistry of the normal and ischemic cardiac muscle

- Development of a measuring system with a "brush" consisting of about 200 electrodes placed on the cardiac muscle wall for the study of electrophysiological mechanisms and treatment of disturbances in the heart rhythm
- Development of measuring methods and models for local and transmural changes in the dynamics of the cardiac muscle under normal conditions and ischemia due to complete or partial closure of the coronary artery
- Development of a method to quantify biochemically ischemic damage of the cardiac muscle based on the enzyme release by necrotic tissue

4.2 Development and evaluation of ultrasound systems

- For applications to the cardiovascular system
- Development of a pulsed Doppler measuring system for blood-velocity profiles and changes in blood-vessel diameters
- Development of a display technique for high-frequency pulse-echo systems working in real time

4.3 Microcirculation

- Applied to blood vessels with a diameter down to 5 μm
- Development of measuring techniques for blood pressure and blood-velocity, applying microscopy and fluorescence techniques
- To investigate the circulation in the bed of the terminal vessel where the blood flow is controlled and the metabolic exchange with the tissues takes place

4.4 Hypertension

- Development of compartment models for the distribution of antihypertensive medicines in the body and for their effects on the body
- Adaptations of measuring techniques to assess this information in small animals (rats)
- Development of an ultrasound Doppler system to evaluate pressure-blood flow relationship in blood vessels less than 1.5 mm in diameter
- Investigation of micropumping systems enabling regional administration of pharmaca
4.5 **Formation of thrombin**

- The development of a computer-based ellipsometer to study the reactions of proteins on a membrane surface (based on changes in the light-reflection properties during reaction)
- Applied in research of the formation of thrombin out of proteins on a phospholipid membrane

4.6 **Physical and mental load**

- The development of measuring methods for determining physiologically relevant data with respect to physical exercise

4.7 **Nutrition and metabolic processes**

- The development of a measuring chamber to obtain information in relation to physical exercise and food
5.1. Cardiovascular technology

- Development of components for the heart-lung machine: gasbubble detector, automated cardiotomy syphon, autotransfusion system, blood pumps
- Signal processing for diagnostic purposes: PAIN, VCG/ECG (on line), EVR (on line), cineangio cardiographic research into the function of the ventricle, documentation on cardio-anaesthesia
- High-resolution gamma camera
- Computer-driven heart stimulator
- Blood circulation in the skin by means of laser-Doppler technique
- Automatic flow measurement in the extremities of the body
- Rapid automatic blood-pressure meter

5.2. Lung function / gas transport technology

- Measuring systems for gas exchange processes: continuous foetal pO₂ measurement, O₂-use and CO₂-production per inhalation, two-colour reflection oximeter, O₂-affinity of haemoglobin in blood
- Lung-function research in artificially respirated patients: diffusion capacity, short-lived radioactive isotopes (¹³N, ¹¹C), artificial respiration equipment, automating of FRC
- Components of the heart-lung machine; cathaferometer as a pO₂/pCO₂ sensor, high-frequency ventilation
- Catheter for continuous measurement of blood pH in vivo
- Multi-component analysis of haemoglobin derivatives in human blood

5.3. Muscle-nerve-perception technology

- Development of measuring techniques for the myoneural system: respiration monitor for use in electromyography of the respiratory muscles, EMG and EEG telemetry and recording, multichannel reference amplifier, automatic relaxometry
- Rehabilitation techniques: myo-electrical arm prosthesis, gait analysis, bio-feedback system
- Bite-height measurement for dental protheses
- Automation of electro-ophthalmology
- Phonetograph
- Automation of function diagnosis in neurology
- Raster stereography for prevention of ailments of the back
- Processing of electro physiological signals
- Incubator development
5.4 Artificial tissues and organs

- Cytopolymeric interaction
- Coronary bypass prosthesis, elastic blood-vessel prosthesis for arteriovenous shunts, trachea prosthesis, cornea prosthesis, artificial skin, bonding material
- Reconstruction and replacement of the damaged meniscus
- Usefulness of calcium-triphosphate as bone-substitute

5.5 Oncological techniques

- Image techniques for diagnosis: Positron Emission Tomography (PET), Faxitron X-ray photographs, computer tomography/echography, NMR, flow cytometer with a laser light source
- Applications of the medical cyclotron; automation synthesis short-lived radiopharmaca for PET
- Treatment of tumours: hyperthermia, Cavitron Ultrasonic Aspirator (CUSA), intra-operative irradiation, femur-endoprosthesis systems
- Picture analysis (quantitative) of cells, parts of cells and tissues (software)

5.6 Medical biotechnology

- Drug targeting by means of liposomes and glycoproteins
- Construction of DNA vectors for gen substitution in enzyme-deficient cells
- Preparation and application of monoclonal antibodies for virus and tumour diagnosis in vitro and in vivo
- Design and application of peptide fragments as a possible vaccine against virus infections
- Application of HPLC techniques (peptides, amino-acids, viral and bacterial proteins)
- Plant-cell culture for the preparation of pharmaca

5.7 Sundry

- Systems for medicine release in the body: glucose sensor, oral zero-order system
- Servo-system for examining the function of the bile ducts
- Automatic recording of urine production
- Research into the function of the skin, percutaneous loss of water
- Fatigue phenomena of osteosynthetic material
- Determination of allergen content of the air
6.1 Medical statistics and informatics

- Development of models, methods and techniques in statistics and informatics applied to medical research, diagnosis, prognosis and patient surveillance
- Hospital information system (HIS)
- Programme package for statistical pattern recognition (ALLOC)
- Analysis of clinical data; rapid automated microscopic morphometry (LEYTAS project)

6.2 Cytochemical and cytometric methods for automation of histodiagnostics and cytodiagnostics

- Specific and quantitative detection of molecular components in cells and tissues (acids, proteins, enzymes)
- Physico-chemical models which simulate the matrix-character of reactions in microscopic slides
- Computer programs for cytophotometry and cytofluorometry in combination with scanning and TV microscopes
- Flow-cytometer and flow-sorting equipment

6.3 Development and methodology for diagnostics and therapy

- Development and application of alloplastic middle-ear prostheses
- Scintigraphic research; diagnostic possibilities, new detection equipment; programming software for image processing
- Working conditions in the operating theatre; reduction of air pollution arising out of inhalation anaesthetics; improvement of drainage systems
- Urodynamics of the lower urinary ducts; development of diagnostic techniques
- Development of radiopharmaca

6.4 Heart, lungs and coagulation of the blood

- Development of impedance catheters for the evaluation of the pump function of the normal and anomalous heart
- Relation between contraction and electrical activation of the myocardium; myocardial mechanics at cellular and organic level
- Control systems for respiration and circulation; early diagnosis of anomalies of the lung
- Physics of circulation; (flow) mechanics and transport of matter with special reference to the coronary circulation
6.5

High-grade technologies for basic medical research

- Extremely fast voltage clamp amplifiers for research into cell membrane
- Laser diffraction technique for determining the length of sarcoma in small muscles

6.6

Medical biotechnology

- Production of monoclonal antibodies
- Production of restriction enzymes
7.1 Information processing in biological organisms

- Automated measuring equipment for single-fibre electromyography
- Development of a transportable measuring equipment for quantitative investigation of disturbed motor systems for the purposes of diagnosis and control of therapy in neuromuscular diseases

7.2 Image processing in medicine

- Research and development of generally applicable image processing techniques: segmentation, topology, digital filtering, pattern recognition, for the purposes of medical diagnostics
- Applied research in the field of: digital radiography (picture archiving and communication systems), digital subtraction angiography, computer-assisted tomography, NMR tomography, CT of gamma emissions, microscopy, cytofluorometry, NMR spectroscopy of heart and tumours

7.3 Diagnostics of the eye with the aid of reflected light

- Densitometry of the visual pigment
- Fluorometry: determining leakage from the retinal circulation to the vitreous body
- Ellipsometry: determining the double-refractive properties of cornea and photoreceptors; determining the orientation of the photoreceptors
- Scanning laser ophthalmoscope: two-dimensional densitometry of the visual pigment

7.4 Pulmonary gas transport and pathogenesis of obstructions in the respiratory ducts

- Development of an automated equipment for determining the diffusion capacity of the lungs with the aid of carbon monoxide (single-breath method, re-breathing method)
- Development of an automated parameter estimate of the flow-volume curve of breathing

7.5 Reactions of the skin to physical and chemical influences from the environment

- Basic research into (over)sensitivity of the skin to light
- Curing oversensitivity and other skin diseases by means of light
• Development of equipment for this purpose: set-up for obtaining light of a required range of wavelengths and sufficiently high intensity for diagnosis and therapy; radiation cabins for phototherapy in the case, for instance, of psoriasis and eczema

7.6 Pathophysiology of atherosclerosis

• Development of perfusion chambers for the in vitro study of adhesion by blood platelets to the walls of blood vessels; also suitable for studying in vitro effects of medicines

7.7 Protection of the heart threatened by ischemia

• The development of an automated system for catheter mapping and display of the electrical cardiac activity in three dimensions

7.8 Chemical and medico-biological research into radiopharmaca

• Development of radiopharmaca, including those for cerebral-flow studies
• Applications of short-lived positron emitters in pharmacca used in nuclear-medicine examinations

7.9 Sundry

• External fixator for treating open bone fractures (patent)
• Implantable, multigated, ultrasound, Doppler-flow transducers for minor blood vessels
• Methods for local hyperthermia with the aid of electromagnetic fields of special form used in combined radiotherapy and hyperthermia of tumours
• Calculation of electromagnetic fields for stimulation of bone growth
8.1 The physically handicapped persons

- Upper limb: prostheses; orthoses; proprioception
- Communication: assist devices for motory and sensory disabled
- Evaluation studies: how to treat the newly handicapped; rehabilitation methods
- Movement studies: arm movements; neurological control of locomotion; remote-controlled analysis of locomotion
- Adapted construction of buildings: accessibility, architectural design
- Development and evaluation of rehabilitation assist devices

8.2 Imaging techniques

- Position sensitive detection of radiation
- Nuclear Magnetic Resonance: resolution improvement; superconductive coil
- Ultra-sound medical diagnosis system: resolution improvement; development of sensors
- Reconstruction methods in nuclear medicine: software equipment evaluation
- Quantitative analysis of angiograms and scintigrams: image-processing techniques
- Pattern recognition in medical diagnosis: classification of chromosomes; detection of mitosis

8.3 Ergonomics and safety

- Cybernetical and informational ergonomics: visual information transfer and control tasks; process regulation; picture screen stations; cockpits
- Anthropometry and biomechanics: data bases; quantification of physical load
- Safety in health care

8.4 Audiovestibular system

- Psychophysics: electrophysiology; mechanics of the inner ear

8.5 Signal processing and instrumentation

- Measurement systems: transducers
- Signal analysis: variability of the hearth rhythm; spike-detection in
8.6 Model and simulation

- Rheology of blood; hydrodynamics
- Health centres: design and evaluation
- Speech acoustics in buildings
- Relation between eye-movement patterns and presented information

8.7 Nuclear bioengineering (Interuniversity Reactor Institute)

- Trace element metabolism
- Synthesis of radiopharmaceuticals
- Multi-trace-element analysis for biomedical samples
- Health physics
9.1 Human perception

- Perceptive information processing in interaction with equipment and software; hearing, seeing, reading, cognition and communication
- Product ergonomy; aids for the perceptively handicapped

9.2 Organisation and management

- Organisational structure; working climate; costs and budgeting; interorganisational cooperation
- Nursing; clinical and polyclinical work; first-line medicine; building of hospitals; training courses in this field
- Medical technology assessment (MTA) studies

9.3 Internal climate

- Environment inside buildings; safety and comfortableness during certain activities; hospital departments, old-age homes, etc.
- Control systems for low energy consumption
- Working conditions in and round the operating theatre and ancillary departmens

9.4 Biomechanics

- Muscle-joint system; long-established research into joint mechanics
- Blood-flow effects; interactions between flowing media and the systems surrounding them
- Viscoelastic materials

9.5 Physiological chemistry

- Advanced analytical instrumentation
- Clinical applications and basic research
- Active for a long period in kidney/artificial-kidney processes and steroid hormones

9.6 Electrical engineering in medicine

- Biomedical applications of measuring techniques, process techniques, process identification, parameter estimation
• Long-term activity in anaesthesia, ultrasound with the accent on imaging techniques and development of instruments for the handicapped

9.7
Biophysics

• Analysis of physical measuring methods
• Stability of lung alveoli
• Indicator-dilution method for the determination of blood-flow-intensities
• Transport phenomena in biosystems and in clinical equipment
• Cyclotron applications: analysis of tracer elements in biomedical liquids and tissues; production method for short-lived radionuclides for medical purposes

9.8
Thematic research

• Cardiac-valve prostheses: long-term basic interest in the working and structure of the human aortic valve, directed towards insight into the design of cardiac-valve prostheses
• Atherosclerosis: development and evaluation of measuring methods for early detection of slight strictures in veins
• Blood technology: diagnostics and treatment in disturbances of the normal composition of the blood
10.1
**Mechanical engineering in biomedicine**

- Lubrication mechanisms in the synovial joints
- Affixing of prostheses for the knee
- Noninvasive, adjustable, growth prosthesis in the tibia and/or femur
- Distortions and strain in tissues in close proximity to exterior supports
- Prevention of back ailments
- Noninvasive blood-rate measurement
- Haemodynamics and blood-vessel geometry

10.2
**Biomedical information technology**

- Active source impedance of the heart
- Modeling of motor-unit action potentials
- Electric conduction in skeletal muscle tissue
- Electromyography for clinical application
- Volume conduction and EEG
- Epileptoid activity in two-dimensional brain sections
- Automatic analysis of exercise electrocardiography
- Foetal ECG
- Development of measuring devices for use in blood vessels on the basis of the ion-sensitive field-effect transistor (ISFET)
- Reduction of system errors in X-ray exposures
- Localisation of sources in the electro-encephalography with inverse techniques
- Development of neuroprostheses
- Automation in clinical chemistry
- Development of biosensors

10.3
**Biomedical materials technology and pharmaceutical chemistry**

- Interaction of materials with blood
- Interaction of materials with tissues
- Interaction of materials with bacteria
- Antithrombogenic polymers
- Application of polymers in reagents and in artificial organs
- Biologically degradable synthetic materials
- Prodrugs
- Synthesis of mitomycin and β-lactams
10.4

Biophysical technology

- Raman microspectroscopy
- Raman spectroscopy of nucleic acids and proteins
- Flow cytometry
- Biomagnetism
- Theoretical immunology
- Rheology of artificial saliva
Medical Technological Department (MTD-TNO)

- Study of the practical value of medical equipment with emphasis on: efficacy, safety, interference-production and -susceptibility
- Development of criteria, measuring methods and procedures for own studies, for support of policy-makers, and for development of standards in the field of medical equipment
- Compliance tests of medical equipment against standards and quality requirements in order to improve the quality of the product and its export-possibilities
- Coordination of comparative studies and promotion of mutual recognition and exchange of testresults among international testing institutes
- Rendering advice and providing information through the Advisory Centre of the MTD: Support of medical institutions in purchasing, use and maintenance of medical equipment; compilation and updating of data bases concerning medical equipment and medical-technological expertise; if necessary consulting experts elsewhere in TNO
- Current subjects of study: electrosurgery, infusion-systems, ultrasound dosimetry, pacemaker interference, safety of installations

Bureau for Provisions for the Handicapped (BVG-TNO)

- Co-ordinating centre for research and development within TNO and the Institute for Rehabilitation Research (IRV) in the field of rehabilitation and aids for the handicapped
- Preparatory research for formulating policies and the survey of problems
- Research into the quality and usefulness aids
- Research directed to product development and product improvement, including the production methods
- Rehabilitation research/supporting research
- Current interest: wheelchairs, communication aids, sensors and manipulators, orthopaedic aids, application of modern materials
12.1
Organs of perception

• Visual system: primary processes, colour, contrast, structure, coding systems
• Development of a portable VEP analysis system
• Development of test equipment for colour vision
• Auditive system: frequency selectivity, methodology

12.2
Medical informatics and statistics

• Statistics; development and application of methods and techniques for the purposes of medical research
• Signal analysis of EEG and evoked responses; topology (mapping)
• Development of systems for the digital recording and processing of physiological signals: EEG, EMG

12.3
Heart and circulation

• Electrophysiology of the ischemic heart; development of a computer model of cardiac rhythm and conduction disturbances; multi-electrode epicardial measurements; endocardial mapping during operations; ventricular tachycardia
• Development of methods for the detection of the His's-bundle activity at the thoracic wall
• Development of (bedside) equipment for recording of peak-heart-potential charts (Body Surface Mapping)
• Development of precise cardiac-output measurement during artificial respiration (thermodilution)
• Physiology of blood circulation; variability of cardiac rhythm and blood pressure; 24-hour blood-pressure recording

12.4
Image analysis and image processing

• 3D image processing; spatial reconstruction of anatomical material (embryonic rat heart) and CT scan exposures
• Optimisation of display techniques in X-ray photography
• Statistical analysis of binary (black/white) patterns; pattern recognition and quantitative evaluation of CT scans
12.5 Measurement and recording methods for the purposes of diagnostics

- Development of a miniature multichannel telemetry system for physiological signals
- Evoked-response measurements and cerebral blood stream measurements (Xe 133 method) for early detection of cerebral ischemia
- Development of recording methods in urology: measurement of urological flow, recording of incontinence
- Development of equipment for the measurement of the condition of the ankle ligaments

12.6 Experimental surgery

- Application of collagen from the skin of sheep as biomaterial
- Research into the closing mechanism of sphincters; development of methods
13.1

**Medical informatics**

- Biological signal processing: ECG; segmentation of EEG; intensive monitoring
- Image processing in nuclear, radiological and microscopic applications
- Pattern recognition and diagnostics; interactive statistical recognition and classification; expert systems for medical decision making
- "Data base management" systems for research support
- Clinical support systems: software; department-oriented systems; support for extramural care

13.2

**Haemodynamics**

- BMT developments of components for model studies on the blood circulation
- Hydrodynamic resistors
- Electromagnetic stream sensors for diameters of 10-25 mm.
- Rapid pneumatic and pneumatic-electromagnetic valve systems
- Function-driven hydrodynamic pump
- Distance measurement for ultrasound (transit time principle)
- Microtemperature and force sensors

13.3

**Medical physics for clinical examinations**

- Variability of the heart rhythm: coaxial electrodes, signal analysis; bloodless measurement of His's-bundle activity
- Visual system: measurement and recording method for eye movements, VEP, pupilography; eye parameters by means of ultrasound
- Cell physics: microelectrode technique for examination of the cardiac-muscle cell
- Differential-impedance plethysmography for determining the liquid in the thorax
- Development of physical measuring methods for research into prevention of decubitus
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<td>ultrasonic diagnostics (8.2, 2.1)</td>
<td></td>
</tr>
<tr>
<td>ergonomics of informatics, visual data transfer (8.3)</td>
<td></td>
</tr>
<tr>
<td>methods for image reconstruction (8.3, 7.2)</td>
<td></td>
</tr>
<tr>
<td>inner-ear mechanics (8.4, 12.1)</td>
<td></td>
</tr>
<tr>
<td>rheology of the blood (8.6, 6.4)</td>
<td></td>
</tr>
<tr>
<td>anaesthetics (9.6, 6.3)</td>
<td></td>
</tr>
<tr>
<td>health-service sciences relating to hospitals (9.2)</td>
<td></td>
</tr>
<tr>
<td>human perception (9.1)</td>
<td></td>
</tr>
<tr>
<td>cardiac valve (9.8, 6.4, 4.1)</td>
<td></td>
</tr>
<tr>
<td>atherosclerosis (9.8, 4.2, 8.6)</td>
<td></td>
</tr>
<tr>
<td>rheology of artificial saliva (10.4)</td>
<td></td>
</tr>
<tr>
<td>visual system (12.1, 9.1, 3.2)</td>
<td></td>
</tr>
<tr>
<td>Body Surface Mapping (12.3, 3.1)</td>
<td></td>
</tr>
<tr>
<td>application of skin collagen of sheep (12.6, 10.3)</td>
<td></td>
</tr>
</tbody>
</table>

* for abbreviations see pages 29-32
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  tel. 020-5482753
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>allergen</td>
<td>any substance capable of inducing an allergy</td>
</tr>
<tr>
<td>allo-</td>
<td>different</td>
</tr>
<tr>
<td>anaesthesia</td>
<td>loss of sensation, but not of vital functions, through administration of anaesthetic agents</td>
</tr>
<tr>
<td>angiography</td>
<td>X-ray imaging of blood vessels, etc. after injection of contrast medium</td>
</tr>
<tr>
<td>anthropometry</td>
<td>comparative study of sizes and proportions of the human being</td>
</tr>
<tr>
<td>arterio</td>
<td>relating to artery or arteries</td>
</tr>
<tr>
<td>audiovestibular</td>
<td>relating to the anterior chamber of the ear</td>
</tr>
<tr>
<td>BMT</td>
<td>biomedical technology</td>
</tr>
<tr>
<td>His's bundle</td>
<td>the auriculo-ventricular bundle in the mammalian heart</td>
</tr>
<tr>
<td>cardio-</td>
<td>relating to the heart or cardiac sphincter of the stomach</td>
</tr>
<tr>
<td>cerebral</td>
<td>relating to the cerebrum</td>
</tr>
<tr>
<td>cine-</td>
<td>axis</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbonic acid gas</td>
</tr>
<tr>
<td>collagen</td>
<td>fibrous scleroprotein in connective tissue</td>
</tr>
<tr>
<td>cornea</td>
<td>anterior covering of the eyeball</td>
</tr>
<tr>
<td>corona</td>
<td>crownlike</td>
</tr>
<tr>
<td>CT</td>
<td>computer tomography</td>
</tr>
<tr>
<td>cybernetics</td>
<td>control of organic functions by means of feedback</td>
</tr>
<tr>
<td>cyto-</td>
<td>cell</td>
</tr>
<tr>
<td>3D-</td>
<td>three-dimensional</td>
</tr>
<tr>
<td>decubitus</td>
<td>the chronic skin ulcers due to continued pressure</td>
</tr>
<tr>
<td>dermal</td>
<td>relating to the skin</td>
</tr>
<tr>
<td>DNA</td>
<td>desoxyribonucleic acid</td>
</tr>
<tr>
<td>dosimetry</td>
<td>dose measurement (energy, radiation)</td>
</tr>
<tr>
<td>dynamometry</td>
<td>measurement of muscular force</td>
</tr>
<tr>
<td>ECG</td>
<td>electrocardiogram; the curve obtained when recording potential variations generated at various places in the body by the activity of the heart muscle</td>
</tr>
<tr>
<td>echogram</td>
<td>recording of reflected ultrasonic vibrations by recording the electric currents generated by the activity of the brain</td>
</tr>
<tr>
<td>EMG</td>
<td>electromyogram; curve obtained by recording potential differences in the muscles in the course of contraction</td>
</tr>
<tr>
<td>endo-</td>
<td>in, within</td>
</tr>
<tr>
<td>endocardium</td>
<td>layer of endothelium lining the heart cavities</td>
</tr>
<tr>
<td>epi-</td>
<td>on</td>
</tr>
<tr>
<td>EVR</td>
<td>Endocardial Viability Ratio</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>pharmacon</td>
<td>medicine, drug</td>
</tr>
<tr>
<td>femur</td>
<td>thighbone</td>
</tr>
<tr>
<td>phonetics</td>
<td>science concerned with the physical and physiological aspects of speech sounds</td>
</tr>
<tr>
<td>FRC</td>
<td>Functional Residual Capacity</td>
</tr>
<tr>
<td>physiology</td>
<td>science of the functioning of living organisms</td>
</tr>
<tr>
<td>gastro-</td>
<td>relating to the stomach</td>
</tr>
<tr>
<td>glycoproteins</td>
<td>compounds of a sugar and a protein</td>
</tr>
<tr>
<td>haemodynamics</td>
<td>science of the movement of the blood</td>
</tr>
<tr>
<td>histo-</td>
<td>tissue</td>
</tr>
<tr>
<td>HPLC</td>
<td>High Performance/Pressure Liquid Chromatography</td>
</tr>
<tr>
<td>hydro-</td>
<td>water</td>
</tr>
<tr>
<td>hypertension</td>
<td>high blood pressure</td>
</tr>
<tr>
<td>hyperthermia</td>
<td>extremely high fever (41°C)</td>
</tr>
<tr>
<td>intra-</td>
<td>in</td>
</tr>
<tr>
<td>ischemia</td>
<td>inadequate supply of blood to an organ or part as from an obstructed blood flow</td>
</tr>
<tr>
<td>catheter</td>
<td>rigid or flexible tube for removing liquids or gases through body channels</td>
</tr>
<tr>
<td>laser</td>
<td>Light Amplification by Stimulated Emission of Radiation. Electromagnetic radiation in the UV, visible-light or infrared range after amplification of atomic vibrations</td>
</tr>
<tr>
<td>liposomes</td>
<td>particles present in tissue in emulsion form and containing fatty or oily globules in cytoplasm</td>
</tr>
<tr>
<td>mitosis</td>
<td>ordinary cell division</td>
</tr>
<tr>
<td>morphometry</td>
<td>measuring the forms of organisms</td>
</tr>
<tr>
<td>motor unit</td>
<td>precornual cell, its offshoots and muscle fibres inntervated by the offshoots</td>
</tr>
<tr>
<td>myo-</td>
<td>muscle</td>
</tr>
<tr>
<td>neuro-</td>
<td>nerve</td>
</tr>
<tr>
<td>NMR</td>
<td>Nuclear Magnetic Resonance, nuclear spin resonance; imaging technique enabling chemical composition of parts of the body to be determined</td>
</tr>
<tr>
<td>oncology</td>
<td>study, classification and treatment of tumours</td>
</tr>
<tr>
<td>O₂</td>
<td>oxygen</td>
</tr>
<tr>
<td>ophthalmo-</td>
<td>relating to the eye</td>
</tr>
<tr>
<td>orthesis</td>
<td>a device supporting a lamed extremity</td>
</tr>
<tr>
<td>osteo-</td>
<td>bone</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PAIN</td>
<td>pacemaker analysis interface</td>
</tr>
<tr>
<td>pCO₂; pO₂</td>
<td>partial carbon dioxide pressure; partial oxygen pressure</td>
</tr>
<tr>
<td>pH</td>
<td>degree of acidity</td>
</tr>
<tr>
<td>plethysmography</td>
<td>determining volumetric changes in a part of a body, particularly to establish the blood flow in limbs or toes/fingers</td>
</tr>
<tr>
<td>pneumography</td>
<td>graphical recording of respiratory movements of the thorax</td>
</tr>
<tr>
<td>proprioception</td>
<td>perception of internal stimuli</td>
</tr>
<tr>
<td>prosthesis</td>
<td>artificial substitute for missing part of body</td>
</tr>
<tr>
<td>psychophysics</td>
<td>psychological research into the relation between physical stimuli and psychic reactions</td>
</tr>
<tr>
<td>rheology</td>
<td>study of deformation and flow of a liquid (e.g. blood)</td>
</tr>
<tr>
<td>sarcoma</td>
<td>malignant tumour arising in tissue cells</td>
</tr>
<tr>
<td>scintigraphy</td>
<td>ascertaining the intensity of emitted gamma range of an organ or part of the body by means of a scanner</td>
</tr>
<tr>
<td>sphincter</td>
<td>ring of muscle which, by contraction, closes an orifice of the body</td>
</tr>
<tr>
<td>somato-</td>
<td>body</td>
</tr>
<tr>
<td>spatial</td>
<td>relating to space</td>
</tr>
<tr>
<td>synovial</td>
<td>relating to liquid in the joints</td>
</tr>
<tr>
<td>telemetry</td>
<td>transmission of measured magnitude to a distance, the data being transmitted by radio</td>
</tr>
<tr>
<td>thermodilution</td>
<td>indicator-dilution technique</td>
</tr>
<tr>
<td>tibia</td>
<td>shinbone</td>
</tr>
<tr>
<td>thrombin</td>
<td>blood-clotting enzyme</td>
</tr>
<tr>
<td>thrombogen</td>
<td>protein essential to thrombine formation (factor II)</td>
</tr>
<tr>
<td>tomography</td>
<td>technique used to obtain an X-ray photograph of a selected plane section, all other structures in front of and behind it being blurred</td>
</tr>
<tr>
<td>trachea</td>
<td>windpipe</td>
</tr>
<tr>
<td>transducer</td>
<td>converter to another form of energy</td>
</tr>
<tr>
<td>ultrasound</td>
<td>inaudible soundwaves of frequency greater than 15,000/sec.</td>
</tr>
<tr>
<td>uterine</td>
<td>relating to/affecting the uterus</td>
</tr>
<tr>
<td>-vascular</td>
<td>relating to blood- and other vessels</td>
</tr>
<tr>
<td>VCG</td>
<td>vector (space) cardiogram</td>
</tr>
<tr>
<td>venous</td>
<td>relating to blood circulating in the veins</td>
</tr>
<tr>
<td>ventricular tachycardia</td>
<td>abnormally rapid heart rate</td>
</tr>
<tr>
<td>term</td>
<td>definition</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>ventricle</td>
<td>chamber of heart of brain</td>
</tr>
<tr>
<td>VEP (VER)</td>
<td>Visual Evoked Potential (Responses)</td>
</tr>
<tr>
<td>in vitro</td>
<td>method of examination outside the living organism</td>
</tr>
<tr>
<td>in vivo</td>
<td>method of examination in the living organism</td>
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