

UNIVERSITY OF DEBRECEN
MEDICAL AND HEALTH SCIENCE CENTER
MEDICAL SCHOOL
DEPARTMENT OF PHYSIOLOGY

PHYSIOLOGICAL PRACTICE

A LABORATORY GUIDE

Revised edition

DEBRECEN

2007

Authors:

Tamás Bányász, M.D., Ph.D.
Tamás Bíró, M.D., PhD.
Julianna Cseri, M.D., Ph.D.
László Csernoch, Ph.D., D.Sc.
István Jóna, Ph.D., D.Sc.
János Magyar, M.D., Ph.D.
Péter Nánási, M.D., Ph.D., D.Sc.
Zoltán Rusznák, M.D., Ph.D.
Péter Szentesi, Ph.D.
Gyula Szigeti, M.D., Ph.D.

Language editor:

Zoltán Rusznák, M.D., Ph.D.

Technical assistance:

Péter Szentesi, Ph.D.

Edited by:

Norbert Szentandrassy, M.D., Ph.D.
Géza Szűcs, M.D., Ph.D., D.Sc.

Publisher:

Professor László Csernoch, Ph.D., D.Sc.

CONTENTS

	page
PREFACE	3
GENERAL INSTRUCTIONS	4
1. HUMAN DIAGNOSTIC EXAMINATIONS	5
1.1. Function of the cardiovascular system	5
1.1.1. Electrocardiography (ECG), analysis of electrocardiograms	5
1.1.2. Analysis of simulated electrocardiograms	8
1.1.3. Measurement of blood pressure at rest and after physical exercise	8
1.1.4. Examination of the arterial pulse	9
1.1.5. Examination of heart sounds	10
1.2. Function of the respiratory system	11
1.2.1. Determination of the basic respiratory pulmonary parameters	11
1.2.2. Demonstration of abnormal pulmonary parameters	12
1.2.3. Determination of the oxygen consumption and the metabolic rate	13
1.3. Effects of physical exercise on the cardiorespiratory system, study of restitution	14
1.4. Examination of the nervous system and sensory organs	21
1.4.1. Examination of cranial nerves	22
1.4.1.1. The 1 st cranial nerve	22
1.4.1.2. The 2 nd cranial nerve	22
1.4.1.3. The 3 rd , 4 th and 6 th cranial nerves	26
1.4.1.4. The 5 th cranial nerve	28
1.4.1.5. The 7 th cranial nerve	30
1.4.1.6. The 8 th cranial nerve	31
1.4.1.7. The 9 th cranial nerve	33
1.4.1.8. The 10 th cranial nerve	34
1.4.1.9. The 11 th cranial nerve	34
1.4.1.10. The 12 th cranial nerve	35
1.4.2. Examination of general motor function	36
1.4.2.1. Examination of trophism and tonicity	36
1.4.2.2. Muscular strength	36
1.4.3. The sensory system	37
1.4.3.1. Superficial perception and dermolexia	37
1.4.3.2. Depth perception	37
1.4.3.3. Stereognosis	37
1.4.4. Reflex action	38
1.4.4.1. Stretch reflexes	38
1.4.4.2. Superficial reflexes	38
1.4.5. Examination of coordination	39
1.4.5.1. Target tests	39
1.4.5.2. Bárány's test	39
1.4.5.3. Diadochokinesis	39

1.4.5.4. Rebound phenomenon	40
1.4.5.5. Romberg positions	40
1.4.5.6. Walking, walking with closed eyes	40
2. EXPERIMENT ON ISOLATED ANIMAL TISSUES	41
2.0.1. Experimental conditions	41
2.0.2. Recording the mechanical response of muscle	41
2.0.2.1. Procedure of the measurement	42
2.1. Computer operated data acquisition system	43
2.1.1. Measuring analog data using microcomputers	43
2.1.2. Data acquisition and processing	43
2.1.3. The data acquisition program	43
2.1.4. Stimulus protocol	44
2.1.5. Data acquisition	44
2.1.6. Storage of data	44
2.1.7. Data analysis	45
2.1.8. Printouts	45
2.2. Experiments on smooth muscle	46
2.2.1. Experiments on uterine smooth muscle of the rat	46
2.2.1.1. Theoretical background	46
2.2.1.2. Effects of neurotransmitters, their agonists and antagonists	47
2.2.1.2.1. Effects of epinephrine	47
2.2.1.2.2. Effects of acetylcholine	47
2.2.1.2.3. Effects of phenylephrine	47
2.2.1.3. Effects of uterotonic drugs	48
2.2.1.3.1. Effects of histamine	48
2.2.1.3.2. Effects of oxytocin	48
2.2.2. Investigation of the function of visceral smooth muscle in isolated rat intestine	49
2.2.2.1. Theoretical background	49
2.3. Transport properties of red blood cell membrane	50
2.3.1. How to handle the blood samples provided?	50
2.3.2. Cleaning the tools	50
2.3.3. Transport properties of red blood cell membrane	50
2.3.4. Determination of the osmotic resistance of the red blood cells	51
2.3.5. Quantitative analysis of corpuscular elements in blood	52
2.3.5.1. Counting in Bürker counter	52
2.3.5.2. Mélangeur (mixing) pipettes	52
2.3.5.3. Bürker counter	53
2.3.5.4. Solutions	54
2.3.5.5. Dilution of blood	55
2.3.5.6. Filling the Bürker counter	55
2.3.5.7. Setting the microscope	55
2.3.5.8. Cell counting	55
2.3.5.3. Electronic counting	58
2.3.6. Photometric measurement of hemoglobin concentration in blood	58

2.3.7. Hematocrit and Mean Corpuscular Volume (MCV)	60
2.4. Studying the function of peripheral nerves and the innervated muscles	62
2.4.1. The compound action potential	62
2.4.2. Receptor potentials	63
2.4.3. Smooth muscle action potential	62
2.4.4. Tetanus evoked on slow and fast muscles	62
3. COMPUTER SIMULATIONS	65
3.0.1. General introduction to the computer simulations	65
3.0.2. Using the simulations	65
3.0.3. Studying the characteristic of ligand-receptor interaction	66
3.1. Simulation of the action potential and ionic currents in nerve	71
3.1.1. Theoretical background	71
3.1.2. The structure of the program	72
3.1.2.1. Channels	72
3.1.2.2. The voltage clamp	72
3.1.2.3. The current clamp	73
3.1.3. Aspects of the evaluation	73
3.1.3.1. The voltage clamp	73
3.1.3.2. The current clamp	73
3.2. Computer simulation of cardiac action potentials	76
3.2.1. Theoretical background and the model	76
3.2.1.1. Fast action potentials	76
3.2.1.2. Slow action potentials	77
3.2.2. Aspects of the evaluation	77
3.3. Simulation of renal transport mechanisms	79
3.3.1. Theoretical background	79
3.3.1.1. Inulin-like passive transport	79
3.3.1.2. Active transport mechanisms	79
3.3.2. Aspects of evaluation	80
3.3.2.1. Inulin-like passive transport	80
3.3.2.2. PAH-like secretion	81
3.3.2.3. Glucose-like reabsorption	81
3.4. Computer simulation of Frank-Starling-mechanism	82
3.4.1. Theoretical background	82
3.4.2. The program	82
3.4.3. Aspects of evaluation	83
3.4.3.1. Effect of preload	83
3.4.3.2. Effect of change in the peripheral resistance	83
3.4.3.3. Circulatory shock	84
3.5. Computer simulation of the glucose tolerance test	85
3.5.1. Theoretical background	85
3.5.2. Aspects of evaluation	86
3.5.2.1. Normal tolerance	86
3.5.2.2. Decreased tolerance	86
3.5.2.3. Increased tolerance	86

3.5.2.4. Renal threshold	87
3.5.2.5. Liver constant	87
3.5.2.6. Pancreas constant	87
3.6. Investigation of processes in cell physiology using computer simulation	88
3.6.1. Theoretical background	88
3.6.1.1. Investigation of the humoral regulation of intestinal-smooth muscle	88
3.6.1.2. The role of endothelial cells	89
3.6.1.3. Synaptic transmission in the neuromuscular junction	89
3.6.1.4. Identification of an „unknown” pharmacon	90
3.6.2. The structure of the program	91
3.6.2.1. Investigation of the humoral regulation of intestinal-smooth muscle	91
3.6.2.2. The role of endothelial cells	91
3.6.2.3. Synaptic transmission in the neuromuscular junction	91
3.7. Computer simulation of skeletal-muscle function	92
3.7.1. Theoretical background	92
3.7.2. The structure of the program	92
APPENDIX: PRINCIPLE PARAMETERS IN PHYSIOLOGY	94
CONTENTS	99