

TABLE OF CONTENTS

Preface.....	xiii
Chapter 1	1
Introduction	
1.1 The concept of living matter in Physiology.....	10
1.2 The concept of separation.....	10
1.3 The concept of energy.....	13
1.4 The concept of work.....	15
Bibliography.....	20
Chapter 2	21
Separators	
2.1 The electric membrane model	26
2.2 The plasma membrane.....	29
2.2.1 Phospholipids.....	31
2.2.2 Protein	33
2.2.3 Carbohydrates.....	34
2.3 Intracellular membrane.....	35
2.4 The Epithelia	38
Bibliography.....	39
Data Sheet 2.1 The electric membrane model.....	40
Chapter 3	45
Accumulators	
3.1 Energy storage in biological systems.....	46
3.2 The accumulation of potential energy.....	50
3.2.1 Creating different environments in ion composition.....	50
3.2.2 A selectively permeable phospholipid membrane	55
3.2.3 Cells use various forms of energy depending on the function	59
3.2.4 The transport of glucose	63
3.2.5 Restoring gradients: sodium ions.....	65

3.2.6 Restoring gradients: potassium ions.....	66
3.2.7 Restoring gradients: sodium ions and potassium ions.....	68
3.2.8 The electrochemical gradient	72
3.2.9 The membrane potential difference.....	74
3.3 The calcium homeostasis.....	76
3.4 Ionic reserves.....	79
3.4.1 The chemical gradient.....	80
3.4.2 The membrane capacity	81
3.4.3 Conductance or resistance.....	81
3.5 The membrane potential.....	82
3.5.1 The Goldman Equation	84
3.5.2 Ohm's law	84
Bibliography.....	86
Data Sheet 3.1 Donnan balance (Gibbs-Donnan balance).....	87
Data Sheet 3.2 Calculating the equilibrium potential of ions according to the reported concentrations in table 3.2	90
Data Sheet 3.3 The membrane potential in a neuron.....	91
Data Sheet 3.4 The microelectrode.....	93
 Chapter 4	 95
Transporters	
4.1 Diffusion	95
4.1.1 Simple diffusion	96
4.1.2 Diffusion in the presence of a membrane	98
4.2 The movement of water	100
4.2.1 Aqueous pores	100
4.2.2 Water flows.....	101
4.2.3 Osmolarity.....	103
4.2.4 Tonicity.....	103
4.2.5 Water transport	104
4.3 Transporters	106
4.3.1 Facilitated transport.....	107
4.3.2 Active transport	109
4.3.3 Sodium uptake	112
4.3.4 Glucose uptake	113
4.3.5 Counter-current transport	115

4.3.6 Counter-current exchange	118
4.3.7 Counter-current multiplication	119
4.4 Ionic permeabilities as integral membrane protein	121
4.4.1 Aqueous pores as ion channels.....	121
4.4.2 Ionic channels	122
Bibliography.....	125
Data Sheet 4.1 Fick's Law	126
Data Sheet 4.2 Diffusion through a membrane.....	129
Data Sheet 4.3 Na ⁺ /K ⁺ ATPase: functions and properties.....	131
Data Sheet 4.4 The nephron.....	133
Data Sheet 4.5 The sodium channel	135
Chapter 5	139
The communicators 1: the primary signal	
5.1 Excitable cells.....	143
5.2 The action potential.....	144
5.3 Ionic membrane currents are voltage-dependent	148
5.4 Ionic membrane currents are time-dependent.....	151
5.5 The ionic nature of the action potential.....	154
5.6 The ionic bases of the action potential genesis.....	157
5.7 The ionic nature of membrane currents.....	159
5.8 Voltage dependence of membrane ionic currents.....	162
5.9 Time dependence of membrane ion currents.....	166
5.10 Hodgkin and Huxley's equation for sodium and potassium currents	169
5.11 Inactivation of sodium current	177
5.11.1 The curve of h_{∞}	178
5.11.2 Recovery from inactivation.....	179
5.11.3 The physiology of inactivation	180
5.12 From membrane macromolecules to ion channel population dynamics.....	181
5.13 New equations for voltage and time dependent currents	186
5.13.1 Sodium channels.....	186
5.13.2 Potassium channels	188
5.13.3 The new kinetic parameters	191
5.14 Shaping the action potential	193

5.14.1 Sodium and Potassium channels during action potential.....	194
5.14.2 The physiology of inactivation	196
5.14.2 Particular properties of the action potential	197
Bibliography.....	199
Data Sheet 5.1 The impedance in a giant squid axon.....	201
Data Sheet 5.2 The oscilloscope	202
Data Sheet 5.3 Measuring the membrane potential in a giant squid axon	205
Data Sheet 5.4 The voltage-clamp.....	207
Data Sheet 5.5 The patch-clamp	212
Chapter 6	217
Communicators 2: communication between cells	
6.1 Communication mechanisms: electrical communication.....	219
6.1.1 Gap junctions	219
6.1.2 Communication between cells with comparable properties	220
6.2 Communication mechanisms: chemical communication	224
6.2.1 Communication between groups of cells via a mediator	225
6.2.2 The hormone system	227
6.2.3 The nervous system	229
6.2.4 The propagation of the action potential in an axon	231
6.2.4.1 Graduated potential	232
6.2.4.2 The "propagation" of action potentials.....	235
6.2.4.3 "Jumping "propagation of action potentials	237
6.2.5 The cell-to-cell communication via chemical mediator	239
6.3 The chemical synapse	240
6.3.1 Release of neurotransmitter from presynaptic membranes ...	242
6.3.2 Neurotransmitter receptors in the nervous system and muscular system	247
6.3.2.1 Glutamate receptors	248
6.3.2.2 GABA receptors	252
6.3.2.3 Acetylcholine receptors.....	254
6.3.3 Presynaptic and post-synaptic currents and potentials.....	257
6.3.4 Neuromuscular synapse.....	262
6.4 Neuronal firing as a language in the nervous system.....	266
6.5 Autorhythmicity and pacemaker activity	272

6.5.1 The heart pacemaker	273
6.5.2 Neuronal spontaneous action potential rate and autorhythmicity.....	275
Data Sheet 6.1 The junctions between cells.....	277
Data Sheet 6.2 Peristalsis in the digestive tract	281
 Chapter 7	 284
Transformers 1: motors	
7.1 The structures for movement.....	288
7.1.1 Skeletal muscle structure.....	289
7.1.2 Sarcomere	292
7.2 Skeletal muscle contraction.....	295
7.2.1 The excitation-contraction coupling	298
7.2.2 A theoretical model of muscle contraction	302
7.2.3 A molecular model of muscle contraction	311
7.2.4 Biomechanics of contraction	316
7.2.4.1 Passive properties of skeletal muscle.....	317
7.2.4.2 Active properties of skeletal muscle	318
7.2.4.3 Isometric and isotonic contractions	320
7.3 The smooth muscle	328
7.3.1 The excitation-contraction coupling in smooth muscle.....	330
7.4 The heart muscle	330
7.4.1 The cycle of stimulation and contraction in the heart.....	332
7.4.2 Excitation-contraction coupling in the heart muscle	336
Bibliography.....	337
Data Sheet 7.1 The motor unit	339
Data Sheet 7.2 Force and length feedback recordings.....	342
Data Sheet 7.3 The electrical conduction in the heart	345
 Chapter 8	 350
Transformers 2: sensors	
8.1 Olfactory sensors	352
8.1.1 Transformation of chemical stimulus into electrical signal	352
8.2 Taste sensors	354
8.2.1 The transformation of chemical stimulus into electrical signal	356

8.3 Touch sensors	358
8.3.1 The corpuscles of Pacini	358
8.3.2 Meissner's corpuscles	359
8.3.3 Merkel discs	360
8.3.4 Ruffini's corpuscles	360
8.3.5 Transformation of mechanical stimulus into electrical signal	361
8.4 Sound sensors.....	363
8.4.1 The transformation of sound stimulus into electrical signal ...	365
8.5 Balance Sensors	368
8.5.1 Transformation of mechanical stimulus into electrical signal ...	370
8.6 Light sensors	372
8.6.1 The retina.....	374
8.6.2 Cones and rods	376
8.6.3 The transformation of light stimulus into electrical signal	378