

Contents

Foreword	v
Acknowledgements	vii
Introduction	xiii
A Note on Units and Symbols	xv
Normal Values	xvi
Chapter 1 Electrical Properties of Cells	1
1.1 The Resting Membrane Potential	2
1.2 Ion Channels	6
1.3 The Nerve Action Potential	11
1.4 Action Potential Propagation	16
1.5 Synapses and the Neuromuscular Junction	20
Further Thoughts	25
1.6 A Historical Perspective on the Action Potential	25
1.7 Extracellular Recordings of Action Potentials	31
Chapter 2 Muscle as an Excitable Tissue	37
2.1 Basic Properties of Muscle	37
2.2 Mechanical Properties of Muscle	39
2.3 Energetics of Muscle Contraction	43
2.4 Excitation-Contraction Coupling	45
2.5 The Control Over $[Ca^{2+}]_i$ and Force Production	50

Chapter 3	The Digestive System	55
3.1	The Overall Structure of the Digestive System	56
3.2	Gut Motility	58
3.3	Principles of Digestion	62
3.4	Intercellular Signalling in the Digestive System	66
	Further Thoughts	69
3.5	Endocrine Control of Food Intake	69
Chapter 4	The Respiratory System	71
4.1	The Transport of Gases into and out of the Lungs	72
4.2	The Exchange of Gases between the Lungs and the Blood	86
4.3	The Carriage of Gases in the Blood	93
	Further Thoughts	97
4.4	The Alveolar Gas Equation	97
Chapter 5	The Circulatory System	107
5.1	Flow in the Circulatory System	107
5.2	The Cardiac Cycle	114
5.3	Pre-Load and After-Load	117
5.4	Cardiac Output	120
5.5	Venous Return	124
5.6	The Circulation as a Whole	127
5.7	The Pulmonary Circulation	129
5.8	The Starling Filtration-Reabsorption Mechanism	130
	Further Thoughts	133
5.9	Deviations from Darcy's Law	133
5.10	Measuring Cardiac Output	139

Chapter 6	The Kidney and Body Fluids	145
6.1	The Formation of Urine	146
6.2	Examples of the Renal Handling of Substances	152
6.3	The Measurement of GFR	158
6.4	The Measurement of Renal Plasma Flow	160
6.5	The Control of Plasma Osmolarity	162
6.6	The Control of Extracellular Fluid Volume	167
6.7	The Responses to Intravenous Infusion of Distilled Water, Isotonic Saline and Hypertonic Saline	174
	Further Thoughts	177
6.8	Osmotic Pressure, Osmolarity and Tonicity	177
Chapter 7	Integrative Physiology	181
7.1	The Control of Plasma pH	181
7.2	The Control of Arterial Blood Pressure	188
7.3	The Response to Exercise	194
Appendix	Derivations and Theoretical Points	201
	Control in Physiology	201
	Flow, Resistance and Energy	204
	Capacitance	211
	Measuring Pressure	216
	LaPlace's Law	217
	Cell Volume and the Gibbs-Donnan Equilibrium	219
	Simplifying the Cable Equation	222
	Index	227