Contents

Contributors Preface to the first edition		Muscle spindles, Golgi tendon organs and spinal reflexes Overview						
					Preface to the second edition		Muscle spindles	30
					Abbreviations and measurements	xvii	Golgi tendon organs	32
		Spinal reflexes	32					
1 PHYSIOLOGY OF EXCITABLE CELLS	1	The initiation of skeletal muscle contraction	33					
Leavaire chiestine		Sensory receptors	33					
Learning objectives Introduction	1	Classification	33					
The membrane potential	1 1	Mechanisms of receptor activation	33					
The cell membrane	1	Sensation	34					
	2	Pain receptors	35					
The resting membrane potential	7	Reflections	35					
Action potentials	7							
The form of the nerve action potential The ionic basis of the nerve action potential	8	2 PHYSIOLOGY OF THE NERVOUS SYSTEM	39					
The propagated action potential	10	Learning objectives	39					
The ionic basis of the cardiac action potential		Neurons	39					
The action potential in muscle	13	Neuron structure and properties	39					
Voltage-gated ion channels	13	Synaptic transmission	42					
The sodium channel	14	Neurotransmitters	45					
Potassium channels	16	The central and peripheral nervous systems	46					
Calcium channels	16	The blood-brain barrier	46					
Neurotransmitters and receptors: ion channels,	10	Cerebrospinal fluid	47					
G proteins and second messengers	16	Cerebral blood flow and oxygenation	50					
Overview	16	Intracranial pressure (ICP)	51					
G proteins	17	Brain metabolism	52					
Second messengers	18	Classification of sensorimotor neurons	52					
Acetylcholine	18	The sensory system	52					
Catecholamines	19	Motor function and its control	57					
Amino acid transmitters	20	Muscle tone	62					
Neuropeptide transmitters	20	Control of posture	63					
Opioids	20	Electroencephalography	63					
Neurotransmitter release in sympathetic gangli		Evoked potentials	64					
Neuromuscular transmission	21	Consciousness	64					
Structure of the neuromuscular junction	21	Sleep	65					
An overview of neuromuscular transmission	21	The autonomic nervous system	66					
Muscle	24	Functions and structure	66					
Skeletal muscle	24	Hypothalamus	66					
Cardiac muscle	29	Visceral afferent system	67					
Smooth muscle	29	Autonomic ganglia	67					

	Sympathetic nervous system	68		Peripheral chemoreceptors	109
	Parasympathetic nervous system	69		Other factors involved in control of	
	Neurotransmitters	70		ventilation	109
	Receptors	70		Reflex ventilatory responses	110
Reflections		71		Exercise and the control of ventilation Anaesthetic agents and the control of	112
3	RESPIRATORY PHYSIOLOGY	75		ventilation	112
	to a shift sale of			Breath holding	113
	ning objectives	75	Reflections		113
Cellu	lar respiration	76			
	Overview	76	4	CARDIOVASCULAR PHYSIOLOGY	117
	ATP: the currency of cellular energy	76		antina a lata satira a	117
	Anaerobic or aerobic metabolism	77 		ning objectives	117
_	Basic metabolic pathways	77	Fund	etions and layout of the cardiovascular system	118
	tions of the respiratory system	80		General functions	118
Carri	age of oxygen and carbon dioxide in the blood	81		Pumps and circuitry	119
	Haemoglobin	81		Distribution of blood volume in the	
	Oxygen carriage in the blood	82		cardiovascular system	120
	Carbon dioxide carriage in the blood	85	The	heart	121
The r	mechanics of lung ventilation	87		Functional anatomy	121
	Equilibrium between the lung and thorax	87		Cardiac action potentials	123
	Pressures and flow during the breathing cycle	87		Relationship between cardiac action	
	Elastic forces and expansion of the lung	88		potential, muscle contraction and	
	Non-elastic forces and expansion of the lung			refractory periods	125
	Laminar, transitional and turbulent gas flow	89		Excitation-contraction coupling in cardiac	
	Lung volumes	91		muscle cells	125
	The pressure-volume relationship of the lung	92		Generation and conduction of the cardiac	
	Lung compliance	93		action potential	126
	Airways resistance	94		Electrocardiography	127
	The muscles of ventilation	95		Mechanical events of the cardiac cycle	129
	The work of ventilation	95		Biophysical determinants of cardiac muscle	
Gas	exchange in the lungs	97		contraction	131
	Rate of pulmonary exchange of oxygen and			Studies of isolated cardiac muscle	
	carbon dioxide	97		preparations	131
	Rate of transfer of oxygen and carbon			Studies of mechanical performance of the	
	dioxide in arterial and venous blood	97		whole heart	134
	Functional anatomy of the airways, alveoli			Ventricular pressure-volume relationships	136
	and pulmonary capillaries	97	Phys	ical factors governing blood flow through vessels	140
	Diffusion of oxygen and carbon dioxide			Poiseuille's equation	140
	across the alveoli and pulmonary capillaries	98		Observed physiological deviations from	
	Alveolar ventilation and dead space	99		Poiseuille's equation	143
	Anatomical, alveolar and physiological dead			Pressure and flow	144
	spaces	99	Vess	els of the systemic circulation	145
	The oxygen and carbon dioxide composition			General description of the vessels	145
	of alveolar gas	101		Arteries and arterial blood pressure	147
	The pulmonary circulation	102		Arterioles	149
	Venous admixture (shunt)	104		Capillaries	152
	Ventilation-perfusion ratio	106		The lymphatics	155
Cont	rol of ventilation	107		Veins and venous return	155
	The respiratory centre in the medulla	107		The relationship between venous return and	
	Central chemoreceptors	108		cardiac output	158

				Conten	ts vii
Cont	rol of the cardiovascular system	161		Functional anatomy of the kidneys	222
Overview		161		Glomerular filtration	224
	Functional organization of cardiovascular			Control of renal blood flow	227
	sympathetic and parasympathetic nerves			Tubular reabsorption and secretion	229
	in the medulla	162		Renal clearance	233
	Central nervous system control and			The loop of Henle and production of	
	integration of the cardiovascular system	164		concentrated urine	234
	Efferent pathways and effectors	166		Summary of tubular handling of the	
	Sensors and measured variables	167		glomerular filtrate	237
	Effects of the arterial baroreceptor reflex			Hormonal control of tubular function	238
	on arterial blood pressure	169		Control of renal sodium, water and	
	Control of special circulations	170		potassium excretion	241
Integ	grated cardiovascular responses	175		Renal control of acid-base balance	244
	Haemorrhage	175		Mechanisms of action of diuretic drugs	248
	The Valsalva manoeuvre	178	Refl	ections	248
	Exercise	179			
Refle	ections	185	8	ACID-BASE PHYSIOLOGY	251
			Lear	ning objectives	251
5	GASTROINTESTINAL PHYSIOLOGY	189		Definitions	251
Leari	ning objectives	189		The pH system	252
Lcan	Oral cavity	189		Buffers	252
	Pharynx and oesophagus	190		Hydrogen ion balance	252
	Stomach	192		Acid-base homeostasis	253
	Small intestine	198		Whole-body (in vivo) titration curves	257
	Large intestine	203		Compensatory mechanisms	257
D - 41 -	Reflections			Clinical effects of acid-base changes	260
nene		204		Temperature and acid-base control	261
				Clinical aspects of acid-base control	263
6	LIVER PHYSIOLOGY	207	Refl	ections	266
Leari	ning objectives	207	•	DUVISION OCY OF BLOOD	200
	Anatomical aspects	207	9	PHYSIOLOGY OF BLOOD	269
	Functions of the liver	209	Lear	rning objectives	269
	Carbohydrate metabolism	209		Haemopoiesis and its control	269
	Lipid metabolism	210		Red blood cells	270
	Bile production	211		White blood cells	277
	Bilirubin metabolism	211		Platelets	280
	Protein metabolism	212		Coagulation	284
	Phagocytic functions	213		Cell-based theory of coagulation	286
	Storage functions	213		Blood transfusion	289
	Drug metabolism	213		Plasma	293
	Liver blood flow	214	Refl	ections	296
Refle	ections	217			200
_	DENIAL BUNGLOLOGY		10	PHYSIOLOGY OF THE IMMUNE SYSTEM	299
7	RENAL PHYSIOLOGY	219	Lear	rning objectives	299
Leari	ning objectives	219		Innate immunity	299
	Functions of the kidneys	220		Acquired immunity	306
	Fluid and electrolyte balance and dietary			Cytokines	313
	requirements	221		Hypersensitivity	315

	Transplant immunology	318	Tem	perature regulation	373
	Assessment of immune function	318		Afferent temperature sensors	373
	Effects of anaesthesia on immune function	321		Central regulation	373
	Allergic drug reactions in anaesthesia	321		Efferent responses	374
Refle	ections	322		Cutaneous responses to heat	375
ricii		022		Effects of anaesthesia on thermoregulation	376
11	ENDOCRINE PHYSIOLOGY	222	Phys	iology of altered temperature	376
11 ENDOCRINE PHYSIOLOGY		323		Thermoneutral zone	376
Lear	ning objectives	323		Responses to hypothermia	376
	Introduction	323		Responses to high temperatures	378
	Hormone production and secretion	324	Refle	ections	378
	Regulation of hormone secretion	324			
	Actions of hormones	324			
	Hypothalamus	326	13	PHYSIOLOGY OF PAIN	381
	Anterior pituitary	328		THISIOLOGI OF TAIN	
Posterior pituitary	330	Lear	ning objectives	381	
	Pancreatic islets	332		Introduction	381
	Thyroid	337		Peripheral mechanisms of pain	382
	Calcium metabolism	339		Dorsal horn mechanisms	388
	Adrenal cortex	342		Ascending tracts	394
	Adrenal medulla	346		Descending modulation	395
	Erythropoietin	349	Refle	ections	396
	Atrial natriuretic factor	349			
	Sex hormones	350			
Reflections		351	14	MATERNAL AND NEONATAL	
				PHYSIOLOGY	399
12	METABOLISM, NUTRITION, EXERCISE				
	AND TEMPERATURE REGULATION	355		ning objectives	399
			iviate	ernal physiology	399
	ning objectives	355		The demands of pregnancy	399
Meta	abolism	355	D	Physiology of the placenta	406
	Normal energy metabolism	355	Perir	natal physiology	410
	Energy compounds	356		Fetal circulation	411
	Catabolic pathways	356		Fetal respiratory system	413
	Anabolic pathways	361		Haematology	416
	Control of metabolic pathways	362		Acid-base status	417
Nutr	ition	363		Renal function	417
	Nutrients	363		Liver function	417
	Inter-relation between fat and carbohydrate			Metabolic balance	417
	metabolism	364		Nervous system	418
	Dietary energy sources	364		Thermoregulation	418
	Basal metabolic rate	365	Refle	ections	419
	Starvation	366			
Exercise		368	15	PHYSIOLOGY OF AGEING	423
	Energy demands	368	15	THISIOLOGI OF AGEING	-423
	Cardiovascular responses to exercise	371	Lear	ning objectives	423
	Respiratory responses to exercise	372		Functional decline with ageing	423
	Muscle and bone responses to exercise	372		Changes in the nervous system	423
	Gastrointestinal and endocrine effects	372		Changes in the cardiovascular system	424

			Conte	ents ix
	Changes in the respiratory system	425	Physiological effects of altitude	432
	Changes in body compartments	426	Environmental changes with altitude	432
	Changes in renal function	426	Hypobaric environments	432
	Changes in liver function	427	Effects of rapid ascent to altitude	432
	Endocrine changes	427	High-altitude residents	434
	Thermoregulation	427	Physiology of space travel	434
Refle	ections	427	Gravitational forces	
			Increased G-forces	435
16	6 SPECIAL ENVIRONMENTS	429	Physiological effects of weightlessness	435
	SI ECIAL LIVINORIVILIVIS 42		Reflections	436
Leari	ning objectives	429		
Phys	iology of diving	429	Key equations and tables	439
Physical laws		429	Further reading	449
	Direct effects of increased pressure	429	Turther reading	443
	Effects of breathing hyperbaric gases	431	Index	453