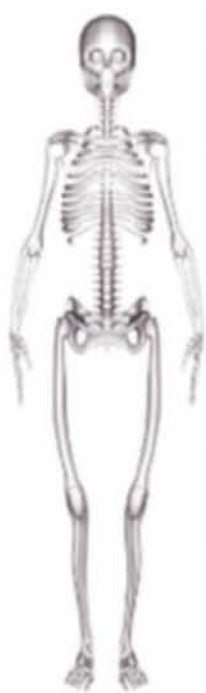


FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY FOR STUDENT NURSES

EDITED BY IAN PEATE AND MURALITHARAN NAIR



 WILEY-BLACKWELL



Fundamentals of Anatomy and Physiology for Student Nurses

CHECK OUT THE
FUNDAMENTALS OF
ANATOMY AND
PHYSIOLOGY
FOR STUDENT NURSES
Companion Website

by visiting www.wiley.com/go/peate

**Click now and gain access to
rich tools and resources**

- Case Studies
- Glossary Terms
- Interactive Multiple Choice Questions
- Interactive True or False Questions
- Flashcards

 **WILEY-BLACKWELL**

NOW
AVAILABLE
ONLINE



FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY FOR STUDENT NURSES

EDITED BY IAN PEATE AND MURALITHARAN NAIR



Home

Case Studies

MCQs

True or False

Multiple Choice Questions

« Return to contents list

Chapter 9. Question 1.

FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY FOR STUDENT NURSES

EDITED BY IAN PEATE AND MURALITHARAN NAIR



Home

Case Studies

MCQs

True or False

Flashcards –
Labels On,
Labels Off

Glossary
Terms

Feedback

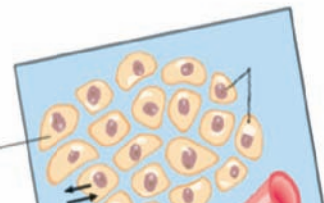
Flashcards – Labels On, Labels Off

« Return to contents list

Chapter 2, Figure 2.10.

Total body
fluid

2/3



Fundamentals of Anatomy and Physiology for Student Nurses

Edited by

Ian Peate

EN(G) RGN DipN (Lond) RNT BEd(Hons) MA(Lond) LLM

Professor of Nursing

Head of School

School of Nursing, Midwifery and Healthcare

University of West London

and

Muralitharan Nair

SRN, RMN, DipN (Lond) RNT, Cert Ed., BSc (Hons) MSc (Surrey), Cert in Counselling, FHEA

Senior Lecturer

School of Nursing, Midwifery and Social Work

Faculty of Health and Human Sciences

University of Hertfordshire

 **WILEY-BLACKWELL**

A John Wiley & Sons, Inc., Publication

This edition first published 2011
© 2011 by Blackwell Publishing Ltd

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing program has been merged with Wiley's global Scientific, Technical and Medical business to form Wiley-Blackwell.

Registered office: John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial offices: 9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK
2121 State Avenue, Ames, Iowa 50014-8300, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

The right of the author to be identified as the author of this work has been asserted in accordance with the UK Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

Library of Congress Cataloging-in-Publication Data

Fundamentals of anatomy and physiology for student nurses / edited by Ian Peate and Muralitharan Nair.

p. ; cm.

Includes bibliographical references and index.

ISBN 978-1-4443-3443-2 (pbk. : alk. paper)

1. Human physiology. 2. Human anatomy. 3. Nursing. I. Peate, Ian. II. Nair, Muralitharan.

[DNLM: 1. Anatomy--Nurses' Instruction. 2. Physiology--Nurses' Instruction. QS 4]

QP34.5.F862 2011

612--dc22

2010040972

A catalogue record for this book is available from the British Library.

Set in 10/12pt Calibri by Toppan Best-set Premedia Limited

Short contents

<i>Contributors</i>	xx	Chapter 9	
<i>Acknowledgements</i>	xxiii	The muscular system	258
<i>Copyright acknowledgements</i>	xxiv	<i>Janet G Migliozi</i>	
<i>Introduction</i>	xxv	Chapter 10	
Chapter 1		The cardiac system	294
Basic scientific principles of physiology	1	<i>Carl Clare</i>	
<i>Peter S Vickers</i>		Chapter 11	
Chapter 2		The respiratory system	328
Cells: cellular compartment, transport system, fluid movements	32	<i>Anthony Wheeldon</i>	
<i>Muralitharan Nair</i>		Chapter 12	
Chapter 3		The circulatory system	366
The immune system	62	<i>Muralitharan Nair</i>	
<i>Peter S Vickers</i>		Chapter 13	
Chapter 4		The digestive system and nutrition	406
Tissue	102	<i>Louise McErlean</i>	
<i>Anthony Wheeldon</i>		Chapter 14	
Chapter 5		The renal system	446
The skin	130	<i>Muralitharan Nair</i>	
<i>Ian Peate</i>		Chapter 15	
Chapter 6		The reproductive systems	476
The nervous system	154	<i>Ian Peate</i>	
<i>Louise McErlean and Janet G Migliozi</i>		Chapter 16	
Chapter 7		The special senses	510
The endocrine system	190	<i>Carl Clare</i>	
<i>Carl Clare</i>		Chapter 17	
Chapter 8		Genetics	550
The skeletal system	224	<i>Peter S Vickers</i>	
<i>Ian Peate</i>		<i>Index</i>	585
		<i>www.wiley.com/go/peate</i>	

Contents

<i>Contributors</i>	xx
<i>Acknowledgements</i>	xxiii
<i>Copyright acknowledgements</i>	xxiv
<i>Introduction</i>	xxv

Chapter 1	Basic scientific principles of physiology	1
<i>Peter S Vickers</i>		
<i>Introduction</i>	2	Compounds 13
Levels of organisation	2	Chemical equations/chemical reactions 13
Characteristics of life	2	Acids and bases (pH) 16
Bodily requirements	4	Blood and pH values 18
Atoms	4	Homeostasis 18
Atomic number	6	Organic and inorganic substances 19
Carbon atom	6	Examples of organic substances 19
Molecules	7	Examples of inorganic substances 20
Chemical bonds	7	Units of measurement 20
Ionic bonding of atoms	7	<i>Conclusion</i> 23
Ions	7	<i>Glossary</i> 23
Covalent bonds	8	<i>References</i> 25
Polar bonds	9	<i>Activities</i> 26
Electrolytes	9	
Elements	10	
Properties of elements	13	

Chapter 2	Cells: cellular compartment, transport system, fluid movements	32
<i>Muralitharan Nair</i>		
<i>Introduction</i>	34	Active transport system 41
Cell membrane	35	Endocytosis 42
Functions of the cell membrane	37	Exocytosis 43
Transport systems	38	Fluid compartments 43

x

Composition of body fluid	46	<i>Conclusion</i>	51
Effects of water deficiency	47	<i>Glossary</i>	52
Electrolytes	47	<i>References</i>	53
Functions of electrolytes	47	<i>Activities</i>	53
Hormones that regulate fluid and electrolytes	50		

Chapter 3 The immune system	62
<i>Peter S Vickers</i>	
<i>Introduction</i>	64
Blood cell development	64
Organs of the immune system	67
The thymus	67
The lymphatic system	68
Lymph nodes	70
Lymphoid tissue	70
The spleen	71
Types of immunity	72
The innate immune system	72
Physical barriers	72
Mechanical barriers	73
Chemical barriers	73
Blood cells	73
Blood cells of the immune system	73
Phagocytosis	74
Cytotoxicity	76
Inflammation	76
The acquired immune system	79
Cell-mediated immunity (T-cell lymphocytes)	79
Humoral immunity (B-cell lymphocytes)	80
Immunoglobulins (antibodies)	83
Types of immunoglobulins	83
Immunoglobulin G	83
Immunoglobulin A	83
Immunoglobulin M	84
Immunoglobulin E	84
Immunoglobulin D	84
Role of immunoglobulins	84
Natural killer cells	86
Primary and secondary response to infection	86
Primary immune response	86
Secondary immune response	88
Immunisations	89
Passive immunisation	89
Active immunity	90
<i>Conclusion</i>	91
<i>Glossary</i>	92
<i>References</i>	95
<i>Activities</i>	96

Chapter 4 Tissue	102
<i>Anthony Wheeldon</i>	
<i>Introduction</i>	104
Epithelial tissue	104
Simple epithelia	105
Stratified epithelia	108
Glandular epithelia	110
Connective tissue	110
Connective tissue proper	113
Loose connective tissue	113
Dense connective tissue	113
Cartilage	114
Bone	115
Liquid connective tissue	115
Membranes	115
Cutaneous membrane	115
Mucous membranes	115
Serous membranes	117
Synovial membranes	118
Muscle tissue	118
Nervous tissue	118
Tissue repair	119
<i>Conclusion</i>	121
<i>Glossary</i>	122
<i>References</i>	123
<i>Activities</i>	124

Chapter 5 The skin	130
<i>Ian Peate</i>	
<i>Introduction</i>	132
The structure of skin	132
The epidermis	132
Keratinocytes	133
Melanocytes	133
Langerhans cells	133
Merkel cells	133
Stratum basale	134
Stratum spinosum	135
Stratum granulosum	135
Stratum lucidum	136
Stratum corneum	136
The dermis	137
The papillary and reticular aspects	138
The accessory skin structures	139
The hair	139
Skin glands	140
Eccrine glands	140
Apocrine glands	141
Nails	141
The functions of the skin	142
Sensation	143
Thermoregulation	143
Protection	143
Excretion and absorption	144
Synthesis of vitamin D	145
<i>Conclusion</i>	145
<i>Glossary</i>	146
<i>References</i>	147
<i>Activities</i>	148

Chapter 6 The nervous system	154
<i>Louise McErlean and Janet G Migliozi</i>	
<i>Introduction</i>	156
Organisation of the nervous system	156
Sensory division of the peripheral nervous system	157
Central nervous system	157
Motor division of the peripheral nervous system	157
Somatic nervous system	157
Autonomic nervous system	157
Neurones	157
Dendrites	158
Cell body	158
Axons	158
Myelin sheath	158
Sensory (afferent) nerves	160
Motor (efferent) nerves	160
The action potential	160
Simple propagation of nerve impulses	161
Saltatory conduction	161
The refractory period	161
Neurotransmitters	161
Neuroglia	163
The meninges	163
Cerebrospinal fluid (CSF)	164
The brain	166
The peripheral nervous system	170
Cranial nerves	170
The spinal cord	170
Functions of the spinal cord	172
Spinal nerves	173
The autonomic nervous system	176
Sympathetic division (fight or flight)	176
Parasympathetic division (rest and digest)	178
<i>Conclusion</i>	178
<i>Glossary</i>	180
<i>References</i>	182
<i>Activities</i>	183

Chapter 7 The endocrine system	190
<i>Carl Clare</i>	
<i>Introduction</i>	192
The endocrine organs	193
Hormones	194
Effects of hormones	196
Destruction and removal of hormones	197
Control of hormone release	197
The physiology of the endocrine organs	198
The hypothalamus and the pituitary gland	198
Hormones released by the anterior pituitary gland	199

Growth hormone	200	Mineralocorticoids	208
Prolactin	200	Glucocorticoids	208
Follicle stimulating hormone and luteinising hormone (gonadotrophins)	201	Pancreas	211
Thyroid stimulating hormone (TSH)	201	Insulin	211
Adrenocorticotrophic hormone (ACTH)	201	Glucagon	212
The thyroid gland	202	Somatostatin	213
The parathyroid glands	205	<i>Conclusion</i>	213
The adrenal glands	205	<i>Glossary</i>	214
Adrenal medulla	206	<i>References</i>	216
Adrenal cortex	207	<i>Activities</i>	216

Chapter 8 The skeletal system		224
<i>Ian Peate</i>		
<i>Introduction</i>	226	Bone structure and blood supply (histology)
The axial and appendicular skeleton	226	Blood supply
The axial skeleton	226	236
The appendicular skeleton	226	237
Bone and its functions	226	Organisation of bone based on shape
Support	229	237
Movement	229	Long bones
Storage	229	237
Protection	229	Short bones
Production	229	238
Bone formation and growth (ossification)	230	Flat bones
Embryonic formation	231	238
Intramembranous ossification	231	Irregular bones
Endochondral ossification	231	241
Bone length and thickness	234	Sesamoid bones
Bone remodelling	234	241
Bone fractures	235	Joints
		241
		Fibrous joints
		242
		Cartilaginous joints
		242
		Synovial joints
		243
		<i>Conclusion</i>
		243
		<i>Glossary of terms</i>
		247
		<i>References</i>
		249
		<i>Activities</i>
		250

Chapter 9 The muscular system	258
<i>Janet G Migliozi</i>	
<i>Introduction</i>	260
Types of muscle tissue	260
Smooth	260
Cardiac	260
Skeletal	260
Functions of the muscular system	260
Maintenance of body posture	261
Production of movement	261
Stabilisation of joints	261
Protection and control of internal tissue structures/organs	261
Generation of heat	261
Composition of skeletal muscle tissue	261
Gross anatomy of skeletal muscles	262
Microanatomy of skeletal muscle fibre	263
The sarcolemma and transverse tubules	264
The sarcoplasm	264
The myofibrils	264
The sarcomeres	264
Types of muscle fibres	264
Blood supply	265
Skeletal muscle contraction and relaxation	266
Energy sources for muscle contraction	267
Aerobic respiration	269
Oxygen debt	269
Muscle fatigue	269
Organisation of the skeletal muscular system	270
Skeletal muscle movement	271
The effects of ageing	285
<i>Conclusion</i>	285
<i>Glossary</i>	286
<i>References</i>	286
<i>Activities</i>	287

Chapter 10 The cardiac system	294
<i>Carl Clare</i>	
<i>Introduction</i>	296
Size and location of the heart	296
The structures of the heart	297
Heart wall	297
The heart chambers	299
The blood supply to the heart	302
Blood flow through the heart	304
The electrical pathways of the heart	306
The cardiac cycle	309
Factors affecting cardiac output	312
Regulation of stroke volume	313
Preload	313
Force of contraction	313
Afterload	314

Regulation of heart rate	314	<i>Conclusion</i>	315
Autonomic nervous system activity	314	<i>Glossary</i>	317
Baroreceptors and the cardiovascular centre	315	<i>References</i>	321
Hormone activity	315	<i>Activities</i>	321

Chapter 11 The respiratory system	328
<i>Anthony Wheeldon</i>	
<i>Introduction</i>	330
Organisation of the respiratory system	330
The upper respiratory tract	330
The lower respiratory tract	331
Larynx	332
Trachea	333
Bronchial tree	334
Blood supply	336
Respiration	336
Pulmonary ventilation	337
Mechanics of breathing	337
Work of breathing	339
Volumes and capacities	340
Control of breathing	342
External respiration	343
Gaseous exchange	343
Factors affecting diffusion	344
Ventilation and perfusion	345
Transport of gases	345
Transport of oxygen (O ₂)	345
Transport of carbon dioxide (CO ₂)	347
Acid base balance	348
Internal respiration	350
<i>Conclusion</i>	350
<i>Glossary</i>	352
<i>References</i>	357
<i>Activities</i>	357

Chapter 12 The circulatory system	366
<i>Muralitharan Nair</i>	
<i>Introduction</i>	368
Composition of blood	368
Properties of blood and plasma	369
Blood plasma	370
Water in plasma	371
Functions of blood	371
Transportation	372
Formation of blood cells	374
Red blood cells	374
Haemoglobin	375
Formation of red blood cells	375
Life cycle of the red blood cell	376
Transport of respiratory gases	377

White blood cells	378	Blood pressure	389
Neutrophils	379	Physiological factors regulating blood pressure	389
Eosinophils	379	Control of arterial blood pressure	390
Basophils	380		
Monocytes	380	Lymphatic system	391
Lymphocytes	380	Lymph	391
Platelets	382	Lymph capillaries and large lymph vessels	391
Haemostasis	382	Lymph nodes	394
Vasoconstriction	382		
Platelet aggregation	382	Lymphatic organs	394
Coagulation	383	Spleen	394
Blood groups	384	The thymus gland	394
Blood vessels	385	Functions of the lymphatic system	394
Structure and function of arteries and veins	385	<i>Conclusion</i>	396
Capillaries	388	<i>Glossary</i>	397
		<i>References</i>	398
		<i>Activities</i>	398

Chapter 13 The digestive system and nutrition	406
<i>Louise McErlean</i>	
<i>Introduction</i>	408
The activity of the digestive system	408
The mouth (oral cavity)	409
Tongue	409
Palate	409
Teeth	409
Salivary glands	410
Pharynx	413
Swallowing (deglutition)	413
Oesophagus	414
The structure of the digestive system	414
Stomach	416
Small intestine	418
The pancreas	421
The liver and production of bile	423
The functions of the liver	424
The gall bladder	425
The large intestine	425
Digestive tract hormones	427
Nutrition, chemical digestion and metabolism	427
Nutrients	428
Balanced diet	428
Nutrient groups	429
<i>Conclusion</i>	431
<i>Glossary</i>	435
<i>References</i>	439
<i>Activities</i>	439

Chapter 14 The renal system	446
<i>Muralitharan Nair</i>	
<i>Introduction</i>	448
Renal system	448
Kidneys – external structures	449
Kidneys – internal structures	450
Nephrons	451
Functions of the kidney	455
Blood supply of the kidney	456
Urine formation	457
Filtration	457
Selective reabsorption	457
Secretion	459
Hormonal control of tubular reabsorption and secretion	460
Composition of urine	461
Characteristics of normal urine	462
Ureters	463
Urinary bladder	464
Urethra	466
Male urethra	466
Female urethra	467
Micturition	467
<i>Conclusion</i>	468
<i>Glossary</i>	469
<i>References</i>	470
<i>Activities</i>	470

Chapter 15 The reproductive systems	476
<i>Ian Peate</i>	
<i>Introduction</i>	478
The male reproductive system	478
The testes	479
Spermatogenesis	482
Sperm	483
The testes and hormonal influences	484
The scrotum	484
The penis	486
Epididymis	487
The vas deferens, ejaculatory duct and spermatic cord	488
The prostate gland	488
The female reproductive system	488
The ovaries	489
The ovarian cortex	490
Graafian follicles	490
Corpus luteum	490
The ovarian medulla	490
Oogenesis	490
The role of the female sex hormones	490
The menstrual cycle	492
The internal organs	494
The uterus	494
The fallopian tubes	495
The vagina	496
The cervix	496
The external genitalia	497
The breasts	497
<i>Conclusion</i>	497
<i>Glossary</i>	498
<i>References</i>	501
<i>Activities</i>	502

Chapter 16	The special senses	510
<i>Carl Clare</i>		
<i>Introduction</i>	512	The special sense of sight 530
The chemical senses	512	Lacrimal apparatus 531
The sense of smell (olfaction)	512	The eye 531
Olfactory receptors	513	The wall of the eye 531
The olfactory pathway	514	Neural tunic (retina) 533
Olfactory discrimination	514	The chambers of the eye 535
The sense of taste	516	Focusing images onto the retina 536
Taste buds	516	Refraction 536
The taste receptor	517	Myopia, hyperopia and presbyopia 538
The gustatory pathway	519	The processing of visual information 539
The special senses of equilibrium and hearing	520	Central processing of visual information 540
The structure of the ear	520	<i>Conclusion</i> 540
Equilibrium	523	<i>Glossary</i> 540
Pathways for the equilibrium sensations	526	<i>References</i> 543
Hearing	527	<i>Activities</i> 543
The hearing process	529	

Chapter 17	Genetics	550
<i>Peter S Vickers</i>		
<i>Introduction</i>	552	Protein synthesis 559
The double helix	552	Summary of protein synthesis 562
Nucleotides	553	The transference of genes 563
Bases	553	Mitosis 563
Chromosomes	554	Interphase 564
From DNA to proteins	557	Prophase 565
Protein synthesis	557	Metaphase 565
Transcription	557	Anaphase 565
Translation	559	Telophase 565
		Cell division 565
		Meiosis 565

First meiotic division	567	Morbidity and mortality of dominant versus recessive disorders	573
Second meiotic division	568	X-linked recessive disorders	574
Mendelian genetics	569	Spontaneous mutation	575
Dominant genes and recessive genes	570	<i>Conclusion</i>	575
Autosomal dominant inheritance and ill health	571	<i>Glossary</i>	575
Autosomal recessive inheritance and ill health	571	<i>References</i>	578
		<i>Activities</i>	579

Index

585



Contributors

About the editors

Ian Peate

Professor of Nursing
Head of School
School of Nursing, Midwifery and Healthcare
University of West London

EN(G), RGN, DipN (Lond), RNT, Bed (Hons), MA(Lond), LLM

Ian began his nursing career in 1981 at Central Middlesex Hospital, becoming an enrolled nurse working in an intensive care unit. He later undertook three years student nurse training at Central Middlesex and Northwick Park Hospitals, becoming a staff nurse then a charge nurse. He has worked in nurse education since 1989. His key areas of interest are nursing practice and theory, men's health, sexual health and HIV/AIDS. He is currently Head of School.

Muralitharan Nair

Senior Lecturer
School of Nursing, Midwifery and Social Work
University of Hertfordshire

SRN, RMN, DipN (Lond) RNT, Cert Ed., BSc (Hons) MSc (Surrey), Cert in Counselling, FHEA

Muralitharan commenced his nursing career in 1971 at Edgware General Hospital becoming a Staff Nurse. In 1975 he commenced his mental health nurse training at Springfield Hospital and worked as a Staff Nurse for approximately 1 year. He has worked at St Mary's Hospital Paddington and Northwick Park Hospital returning to Edgware General Hospital to take up the post of Senior Staff Nurse and then Charge Nurse. He has worked in nurse education since 1989. His key interests include physiology, diabetes, surgical nursing and nurse education. Muralitharan has published in journals and written a chapter on elimination and published a textbook on pathophysiology. He is a fellow of the Higher Education Academy.

About the contributors

Louise McErlean

Senior Lecturer
School of Nursing, Midwifery and Social Work
University of Hertfordshire

RGN, BSc(Hons), MA (Herts)

Louise began her nursing career in 1986 at the Victoria Infirmary in Glasgow, becoming a registered general nurse. She later completed the intensive care course for RGNs while working in Belfast as a staff nurse. She then worked as a junior sister at the Royal Free Hospital and has worked in nurse education since 2005. Her key areas of interest are pre-registration nurse education and intensive care nursing.

Janet G Migliozi

Senior Lecturer
School of Nursing , Midwifery and Social Work
Faculty of Health and Human Sciences
University of Hertfordshire

RGN, BSc (Hons), MSc (London), PGDEd, FHEA

Janet commenced her nursing career in London becoming a staff nurse in 1988. She has worked at a variety of hospitals across London, predominately in vascular, orthopaedic and high dependency surgery before specialising in infection prevention and control. Janet has worked in nurse education since 1999 and her key interests include microbiology particularly in relation to health-care associated infections, vascular/surgical nursing, health informatics and nurse education. Janet is currently a senior lecturer and a member of the Infection Prevention Society.

Carl Clare

Senior Lecturer
School of Nursing, Midwifery and Social Work
University of Hertfordshire

RN, DipN, BSc (Hons), MSc (Lond), PGDE (Lond)

Carl began his nursing a career in 1990 as a nursing auxiliary. He later undertook three years student nurse training at Selly Oak Hospital (Birmingham), moving to The Royal Devon and Exeter Hospitals, then Northwick Park Hospital, and finally The Royal Brompton and Harefield NHS Trust as a resuscitation officer and honorary teaching fellow of Imperial College (London). He has worked in nurse education since 2001. His key areas of interest are physiology, sociology, cardiac care and resuscitation. Carl has previously published work in cardiac care, resuscitation and pathophysiology.

Peter S Vickers

Visiting Fellow
School of Nursing and Midwifery
University of Hertfordshire

Cert Ed, Dip CD, SRN, RSCN, BA, PhD, FHEA

Following a career in teaching, Peter commenced his nursing career in 1980 at the York District Hospital, followed shortly afterwards by studying and working at the Hospital for Sick Children, Great Ormond Street, London. He later obtained his first degree in Biosciences and Health Studies and then obtained a doctorate in his specialty, immunology nursing, concentrating on the long-term development of children with SCID in the UK and Germany. He has worked in nurse education for several years, and has recently completed a research study into adult palliative care. The author of books on children's responses to early hospitalisation, and research methodology/

proposals, he has also written chapters for several nursing bioscience and pathophysiology books, as well as presented papers at many national and international conferences. His key areas of interest are all aspects of immunology and immunology nursing, infectious diseases, genetics, and research. Although officially retired, he continues to work part-time at the University of Hertfordshire, as well as continuing with his writing and presenting at conferences.

Anthony Wheeldon

School of Nursing, Midwifery and Social Work
Faculty of Health and Human Sciences
University of Hertfordshire

MSc (Lond), PGDE, BSc(Hons), DipHE, RN

After qualification in 1995 Anthony worked as a staff nurse and senior staff nurse in the Respiratory Directorate at the Royal Brompton and Harefield NHS Trust. He began teaching on post-registration courses in 2000 before moving into full-time nurse education at Thames Valley University in 2002. Anthony has a wide range of nursing interests including cardiorespiratory nursing, anatomy and physiology, respiratory assessment and nurse education. Anthony has previously published work on respiratory assessment and pathophysiology. He is currently a senior lecturer at the University of Hertfordshire.

Acknowledgements

We would like to thank all of our colleagues and students for their help, support, comments and suggestions.

Muralitharan would like to thank his wife, Evangeline, and his daughters, Samantha and Jennifer, for their continued support and patience.

Ian would like to thank his partner, Jussi Lahtinen, for all of his continued support and encouragement.

Thank you to Anthony Peate who contributed to some of the illustrations.

Copyright acknowledgements

The following figures were produced with the kind permission of the copyright holders.

Tortora, G.J. and Derrickson, B.H. (2009) *Principles of Anatomy and Physiology*, 12th edn. Hoboken, NJ: John Wiley & Sons.

1.1, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.1, 2.3, 2.5, 2.6, 2.7, 3.1, 3.2, 3.3, 3.8, 3.10, 3.11, 3.12, 3.13, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.14, 4.15, 4.16, 5.1, 5.2, 6.2, 6.3, 6.5, 6.6, 6.7, 6.8, 6.9, 6.11, 6.12, 6.14, 6.15, 6.16, 7.1, 7.7, 7.9, 8.1, 8.2, 8.3, 8.5, 8.8, 8.9, 9.1, 9.3, 9.4, 9.5, 9.10, 9.11, 10.1, 10.2, 10.5, 10.6, 10.8, 10.9, 10.11, 11.1, 11.2, 11.3, 11.4, 11.6, 11.11, 11.12, 11.14, 11.15, 12.1, 12.2, 12.5, 12.6, 12.8, 12.9, 12.10, 12.11, 12.12, 12.13, 12.14, 12.16, 12.18, 12.19, 12.21, 12.22, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 13.11, 13.12, 13.13, 13.14, 13.15, 14.1, 14.3, 14.4, 14.5, 14.6, 14.7, 14.9, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.8, 15.9, 15.10, 15.11, 15.13, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 16.10, 16.12, 16.13, 16.14, 16.15, 16.16, 16.18, 16.19, 16.20, 17.1, 17.2, 17.3, 17.5, 17.6, 17.7, 17.9, 17.10.

Nair, M. and Peate, I. (2009) *Fundamentals of Applied Pathophysiology: An Essential Guide for Nursing Students*. Oxford: Wiley-Blackwell.

2.2, 2.4, 2.10, 2.12, 3.4, 5.3, 5.4, 5.5, 5.6, 7.5, 7.10, 7.11, 7.12, 7.13, 11.5, 11.9, 11.10, 13.16, 14.8, 15.12.

Jenkins G.W., Kemnitz C.P. and Tortora G.J. (2007) *Anatomy and Physiology: From Science to Life*. Hoboken, NJ: John Wiley & Sons.

4.13, Unnumbered illustration from clinical application, Pessary insertion box

Tortora, G.J. (2008) *A Brief Atlas of the Skeleton*. Hoboken, NJ: John Wiley & Sons.

8.6, 8.7.

Tortora, G.J. and Derrickson, B. (2010) *Essentials of Anatomy and Physiology*, 8th edn. New York: John Wiley & Sons.

6.4, 13.10.

Lister Hill National Center for Biomedical Communications (2010) *Genetics Home Reference: Your Guide to Understanding Genetic Conditions*, p.19. <http://ghr.nlm.nih.gov/handbook.pdf>

17.4.

National Heart Lung and Blood Institute

Unnumbered illustration in Clinical application: Myocardial Infarction box

Peate, I. (2009) *Men's Health*. Oxford: Wiley-Blackwell.

15.7.

Introduction

The contributors to this text are all committed to the provision of high quality care. The authors are all experienced academics working in higher education, with many years of clinical experience, knowledge and skills, teaching a variety of students at various academic levels. We are confident that after you have gained a sound understanding of the anatomy and physiology of the various bodily systems you will be able to understand better the needs of the people you have the privilege to care for. High quality care for all is something we should be striving to provide but it is not possible to do this effectively if we do not fully appreciate the whole being, the whole person. This text has been formulated in such a way that we hope you enjoy reading it, and more importantly that you are hungry to learn more, that you will be tempted to delve deeper and that you grow and develop.

The companion to this book, *The Fundamentals of Applied Pathophysiology* (Nair & Peate 2009) will aid in your development and understanding. It is essential in any programme of study related to the provision of care that you are confident and competent in this field of study. It is not enough that you remember all of the facts (and there are many of these) that are associated with anatomy and physiology; you must be able to relate these to the people you care for. Some of these people may be vulnerable and at risk of harm; you have a duty to ensure that you are knowledgeable. *Fundamentals of Anatomy and Physiology for Student Nurses* will help you. The Standards for Pre Registration Nursing Education (Nursing and Midwifery Council, 2010) make it clear that you must be competent in a number of spheres in order to register successfully with the Nursing and Midwifery Council.

The human body is as beautiful on the inside as it is on the outside; the mind and the body when working in harmony is a fantastic machine capable of extraordinary things. Healthcare students work and study both in the hospital and the community setting where they will meet and care for patients with diverse altered anatomical and physiological problems. Using a fundamental approach with a sound anatomical and physiological understanding will provide healthcare students with an essential basis on which to offer care.

Anatomy and physiology

Anatomy can be defined simply as the science related to the study of the structure of biological organisms; many dictionaries use such a definition. *Fundamentals of Anatomy and Physiology for Student Nurses* focuses on human anatomy, and the definition for the purposes of this text is a study of the structure and function of the human body. This allows for reference to function as well as structure; in all biological organisms structure and function are closely interconnected. The human body operates through interrelated systems.

The term anatomy is Greek in origin and means 'to cut up' or 'to dissect'. While the first scientifically based anatomical studies (attributed to a 16th-century Flemish anatomist, doctor and artist, Vesalius) were based on observations of cadavers (dead bodies), modern approaches to human anatomy differ as they include other ways of observation, for example, with the aid of a microscope and other imaging tools. Subdivisions are now affiliated within the broader field of anatomy; the word anatomy is often preceded with an adjective that identifies the method of observation, for example, gross anatomy (the study of body parts visible to the naked eye, for example, the heart or the bones) or microanatomy (where body parts, for example, cells or tissues are only visible with the use of a microscope).

Living systems can be defined from a number of perspectives:

- At the very smallest level, the chemical level, atoms, molecules and the chemical bonds connecting atoms provide the structure upon which living activity is based.
- The smallest unit of life is the cell. Specialised bodies – organelles – within the cell carry out particular cellular functions. Cells may be specialised, for example, bone cells and muscle cells.
- Tissue is a group of cells that are similar and they perform a common function. Muscle tissue, for example, is made up of muscle cells.
- Organs are groups of different types of tissues performing together to carry out a specific activity. The stomach is an organ made up of muscle, nerve and tissues.
- A system is two or more organs working together to carry out a particular activity. The digestive system, for example, comprises the coordinated activities of a number of organs, including the mouth, stomach, intestines, pancreas and liver.
- Another system that possesses the characteristics of living things is an organism; this has the capacity to obtain and process energy, the ability to react to changes in the environment and the ability to reproduce.

As anatomy is associated with the function of a living organism it is almost always inseparable from physiology. Physiology can be described as the science which deals with the study of the function of cells, tissues, organs and organisms.

Physiology is concerned with how an organism carries out its many activities, considering how it moves, how it is nourished, how it adapts to changing environments – human and animal, hostile and friendly. It is the study of life.

Physiology is the foundation upon which we build our knowledge of what life is; it can help us to decide how to treat disease as well as helping us to adapt and manage changes imposed on our bodies by new and changing surroundings – internal and external. Studying physiology will help you understand disease (pathophysiology) arising from this; physiologists are able to develop new ways for treating diseases.

Just as there are a number of branches of anatomical study, so too are there a number of physiological branches that can be studied, for example, endocrinology, neurology and cardiology.

The chapters

There are 17 chapters. The text is not intended to be read from cover to cover, but you may find reading the first three chapters will help you come to terms with some of the complex concepts; we encourage you to delve in and out of the book. The chapters use simple and generously sized full colour art work to assist you in understanding and appreciating the complexities associated with the human body from an anatomical and physiological perspective. There are many features

contained within each chapter that assist you to build upon and develop your knowledge base; we would encourage you to get the most out of this book.

Getting the most out of your copy of *Fundamentals of Anatomy and Physiology for Student Nurses*

The text takes the reader from the microscopic to macroscopic level in the study of anatomy and physiology. The contents demonstrate the movement from cells and tissues through to systems. This approach to teaching is a tried and tested approach when helping learners understand a topic area that can sometimes be seen as complex.

This book has been written with these key principles in mind, to help inform your practice as well as your academic work. A number of features are provided to help bring to life the fascinating subject of human anatomy and physiology.

Each chapter begins with several questions that are posed to test your current knowledge and which will allow you to pre-test. Learning outcomes are provided. These will cover the content within the chapter but only you can do the learning; these outcomes are what are expected of you after reading and absorbing the information. This is a minimum of what you can learn; do not be constrained by the learning outcomes, they are only there to guide you. Where appropriate an anatomical map is provided; the anatomical map is related to the chapter you are reading, this allows you to visualise the anatomy being discussed.

Another feature in the chapter that is provided to help you consider people you care for, to help you make clinical links, are the boxes in most of the chapters called Clinical considerations. These boxes demonstrate the application to your learning citing specific care issues that you may come across when working with people in clinical settings.

At the end of the chapter you are provided with a bank of multiple choice questions that are based on the content of the chapter. Some of the answers to the questions are not found in the text; in this case you are encouraged to seek out the answers helping to develop your learning further.

Other features provided will help you measure the learning that has taken place, for example, true or false, label the diagram, find out more, crosswords or word searches; they are meant to be fun but they also aim to pull together the content of the chapter.

The feature called Conditions provides you with a list of conditions that are associated with the topics discussed in the chapter. You are encouraged to take some time to write notes about each of the conditions that have been described; this will help you relate theory to practice. You can make notes taken from other textbooks or other resources, for example, people you work with in a clinical area, or you may make the notes as a result of people you have cared for. It is important however that if you are making notes about people you have cared for you must ensure that you adhere to the rules of confidentiality.

A glossary of terms is provided at the end of every chapter. We present this to facilitate the learning of difficult words or phrases; understanding these words and phrases is important to your success as a healthcare student. When you have mastered the words your medical vocabulary will have grown and you will be in an ideal position to develop it further.

Patient notes are provided as an accompaniment to the text as a part of the web resources feature. These notes can be read at the beginning of the chapter as this will enable you to relate the issues being discussed to the people you may care for. We would suggest you revisit the patient notes several times as you work your way through each chapter – making a link from

theory to practice and practice to theory. The patient notes are there merely to help you visualise, contextualise and to think about the application of theory to practice.

The use of computers and other electronic resources now play a central role in education as well as the education of nurses and other healthcare students with many universities using virtual learning environments. The electronic resources associated with this book are designed to help enhance your learning; they are varied and informative and are visually stimulating.

The text is accompanied by a raft of electronic resources that will support your learning. These resources can be used in your own place at your own pace. The aim is to encourage further learning and to build upon what you know already. There are also links to other resources. Using the electronic resources alongside the book as well as the human resources you will meet in practice will enhance the quality of your learning. The electronic resources available cannot replace the more conventional face to face learning with other students, lecturers, registered nurses and patients; they complement it.

What's in a name?

The use of terminology is important. Sometimes the term 'the patient' has been used in this text; universally the term is used because it is easier to do so and it is commonly understood. There are some possible dangers with this as it implies the person is in receipt of medical care and this can then mean that the care provider has the upper hand. This suggestion must be avoided at all costs as those in receipt of care are participants and the person offering care should be acting as advocate.

Throughout this text we have chosen to use a multitude of words that may be used to describe the people you care for, for example, patient, person, service user. These words (and many more) are used in everyday practice and you will come across them when you are in clinical and health-care settings. The most important thing to remember is that the people being cared for are people, not labels or names attached to them. The Patients Association (2009) suggest: 'Patients not numbers ... People not statistics'.

When you are caring for people on an individual basis you must ask them what they would prefer you to call them. Some people are content with you addressing them by their first name, others may not be and you must, from the beginning of the therapeutic relationship, determine what the individual prefers; this demonstrates respect.

Just because a person becomes ill, prone to illness or vulnerable, they do not lose all their own values and beliefs, their sense of self as mother, father, lover, partner, brother or sister. How a person is addressed can impact on their health and wellbeing.

You may also note that we have used a variety of words to describe you, the reader. We have done this because we know that many people from a variety of backgrounds will read and use this text. All of us are learners and this is the perspective that we have used when writing this text.

The provision of a world-class health and social care service

The National Health Service (NHS) is the main provider (but not the only one) of health care in the United Kingdom (UK); the NHS belongs to all of us. There are thousands of healthcare workers