

# Contents

Contributors	xvii
Preface	xxi
Acknowledgements	xxv
About the Editors	xxvii
Prefixes, Suffixes	xxix
How to Use Your Textbook	xxxix
About the Companion Website	xli

## 1 Basic Scientific Principles of Physiology 1

Introduction	2
Levels of Organisation	2
Characteristics of Life	2
Bodily Requirements	3
Life at the Chemical Level	4
Chemical Reactions and Chemical Bonds	6
Acids and Bases	10
Representing Chemical Reactions in Written Form: Chemical Equations	11
Organic Molecules	12
Homeostasis	15
Units of Measurement	16
Conclusion	18
Glossary	18
References	19
Activities	19
Test Your Learning	21
Find Out More	21

## 2 Cells, Cellular Compartments, Transport Systems, Fluid Movement Between Compartments 23

Introduction	24
Inside the Cell	24
Structure of the Cell Membrane	25
Transport of Substances Across the Cell Membrane	26
How Do Cells Communicate?	30
Fluid Compartments in the Body	31
The Composition of Body Fluids	31
Electrolyte and Water Balance	32
Fluid Movement Between Compartments	34

Bulk Transport Across the Cell Membrane	37
Conclusion	39
Glossary	39
References	40
Further Reading	40
Activities	40
Find Out More	42
Chemical Symbols	42
Conditions	43

### **3 Genetics** 45

Anatomical Map	46
Introduction	46
Deoxyribonucleic Acid (DNA) and Ribonucleic Acid (RNA)	47
The DNA Double Helix	48
Chromosomes	49
From DNA to Proteins	52
Summary of Relationship Between DNA, RNA and Protein	55
The Transference of Genes	56
Inheritance	60
Spontaneous Mutation	70
Disorders of Chromosomes	70
Conclusion	72
Glossary	72
References	73
Further Reading	74
Activities	74
Conditions	76

### **4 Tissue** 77

Introduction	78
Epithelial Tissue	78
Connective Tissue	83
Membranes	89
Muscle Tissue	90
Nervous Tissue	91
Tissue Repair	92
Conclusion	93
Glossary	93
References	94
Activities	94

### **5 Embryology** 97

Introduction	98
Final Maturation of the Oocyte and Sperm	98
Day One: Fertilisation	100
Days 2–5: Pre-Implantation Development	100
Day 6: Implantation	102
Week 2: Early Placental Formation	102

Week 3–8: Post-Implantation Embryonic Development	104
Late Gestation and Birth: Gestational Weeks 13–40 (Embryonic Weeks 11–38)	108
Complications of Pregnancy	111
Conclusion	115
Glossary	115
References	116
Further Reading	116
Activities	117

## 6 The Muscular System 119

Body Map	120
Introduction	120
Types of Muscle Tissue	120
Functions of the Muscular System	121
Composition of Skeletal Muscle Tissue	122
Gross Anatomy of Skeletal Muscles	122
Microanatomy of Skeletal Muscle Fibre	123
Skeletal Muscle Contraction and Relaxation	127
Energy Sources for Muscle Contraction	130
Aerobic Respiration	130
Organisation of the Skeletal Muscular System	133
The Effects of Ageing	146
Conclusion	146
Glossary	146
References	147
Further Reading	147
Activities	147
Find Out More	149
Conditions	149

## 7 The Skeletal System 151

Body Map	152
Introduction	152
Bone as a Tissue	154
Other Connective Tissues Closely Associated with the Skeletal System	156
Bone Formation	158
Bone Growth	159
Bone Remodelling	161
Bone Fractures	164
The Axial and Appendicular Skeleton	165
Bone Shapes	166
Joints	170
Conclusion	174
Glossary	175
References	176
Further Reading	176
Activities	177
Match Each Bone to its Correct Shape	178
Find Out More	179
Conditions	179

## 8 The Circulatory System 181

Body Map	182
Introduction	182
Components of Blood	182
Properties of Blood	184
Plasma	184
Functions of Blood	184
Formation of Blood Cells	186
Red Blood Cells	187
White Blood Cells	191
Platelets	194
Haemostasis	194
Coagulation	194
Blood Groups	197
Blood Vessels	198
Blood Pressure	202
Lymphatic System	203
Lymphatic Organs	207
Conclusion	209
Glossary	209
References	210
Further Reading	210
Activities	211
Find Out More	212
Conditions	212

## 9 The Cardiac System 215

Body Map	216
Introduction	216
Size and Location of the Heart	216
The Structures of the Heart	217
The Blood Supply to the Heart	223
Blood Flow Through the Heart	228
The Electrical Pathways of the Heart	229
The Cardiac Cycle	233
Factors Affecting Cardiac Output	236
Regulation of Stroke Volume	236
Regulation of Heart Rate	237
Conclusion	239
Glossary	239
References	241
Further Reading	242
Activities	242
Conditions	243

## 10 The Digestive System 245

Body Map	246
Introduction	246
The Activity of the Digestive System	246
The Organisation of the Digestive System	246

The Digestive System Organs	247
The Structure of the Digestive System	254
The Liver and Production of Bile	264
The Gallbladder	266
The Large Intestine	266
Digestive Tract Hormones	268
Nutrition, Chemical Digestion and Metabolism	268
Conclusion	272
Glossary	273
References	275
Further Reading	276
Activities	276
Find Out More	278
Test Your Learning	278
Conditions	278

## 11 The Renal System 281

Body Map	282
Introduction	282
Renal System	282
Functions of the Kidney	290
Blood Supply of the Kidney	292
Urine Formation	292
Selective Reabsorption	293
Hormonal Control of Tubular Reabsorption and Secretion	295
Composition of Urine	296
Ureters	298
Urinary Bladder	299
Urethra	300
Micturition	301
Conclusion	302
Glossary	302
References	303
Further Reading	303
Activities	304
Conditions	305

## 12 The Respiratory System 307

Body Map	308
Introduction	308
Organisation of the Respiratory System	308
The Upper Respiratory Tract	308
The Lower Respiratory Tract	310
Blood Supply	316
Respiration	316
Pulmonary Ventilation	316
Work of Breathing	319
Volumes and Capacities	321
Control of Breathing	323
External Respiration	324
Ventilation and Perfusion	327

Transport of Gases	327
Acid–Base Balance	330
Internal Respiration	330
Conclusion	332
Glossary	332
References	334
Further Reading	335
Activities	335
Conditions	337

## **13 The Reproductive Systems** 339

Body Map	340
Introduction	340
The Male Reproductive System	340
The Female Reproductive System	348
Conclusion	361
Glossary	361
References	363
Further Reading	363
Activities	364
Find Out More	365
Conditions	366

## **14 The Nervous System** 367

Body Map	368
Introduction	368
Organisation of the Nervous System	368
Sensory Division of the Peripheral Nervous System	368
Central Nervous System	369
Motor Division of the Peripheral Nervous System	369
Neurotransmitters	374
Neuroglia	376
The Meninges	376
Cerebrospinal Fluid	377
The Brain	379
The Peripheral Nervous System	383
The Autonomic Nervous System	389
Conclusion	392
Glossary	393
References	394
Further Reading	394
Activities	395
Find Out More	396
Conditions	396

## **15 The Senses** 399

Introduction	400
The Chemical Senses	400
The Senses of Equilibrium and Hearing	408
The Sense of Sight	419

Conclusion	428
Glossary	428
References	430
Further Reading	430
Activities	430
Conditions	432

## **16 The Endocrine System** 433

Body Map	434
Introduction	434
The Endocrine Organs	435
Hormones	437
The Physiology of the Endocrine Organs	439
The Thyroid Gland	443
Glossary	456
References	457
Further Reading	458
Activities	458
Conditions	460

## **17 The Immune System** 461

Body Map	462
Introduction	462
Blood Cell Development	462
Organs of the Immune System	463
The Lymphatic System	464
Lymphoid Tissue	469
Types of Immunity	469
The Innate Immune System	469
Blood Cells	470
The Acquired Immune System	477
Immunoglobulins (Antibodies)	480
Natural Killer Cells	484
Primary and Secondary Response to Infection	485
Hypersensitivity	487
Anaphylaxis	488
Immunisations	488
Conclusion	488
Glossary	489
References	490
Further Reading	491
Activities	491
Find Out More	493
Conditions	493

## **18 The Skin** 495

Body Map	496
Introduction	496
The Structure of Skin	497
The Epidermis	498

Layers of the Epidermis	499
The Dermis	503
The Papillary and Reticular Aspects	503
The Accessory Skin Structures	504
The Functions of the Skin	508
Synthesis of Vitamin D	511
Conclusion	511
Glossary	511
References	512
Further Reading	513
Activities	513
Find Out More	515
Conditions	515
 Normal Values	 517
Answers	521
Index	529