FUNDAMENTALS

THIRD EDITION

Fundamentals of

Children and Young People's Anatomy and Physiology

For Nursing and Healthcare Students

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We would like to dedicate this textbook to children's nurses across the world who are working with children and families, often in extremely difficult and challenging situations, knowing that we all share the same common goal of wanting to improve lives so every child will have a childhood and flourish.

Contents

List of contributors

Mary Brady, RN, RSCN, CHSM, BSc (Hons), PGC T&L HE MSc Senior Fellow HEA

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Mary has a lengthy and extensive knowledge of the clinical care required for children and young people in a variety of settings (neonatal units, paediatric and cardiac intensive care units, and general paediatric wards). She has held sister's posts in a neonatal/infant surgery ward, a neonatal unit and on a general paediatric ward.

Since 2004, she has worked in Higher Education and has held various posts (including skills lead for children's nursing, Branch/Field Lead, Co-Chair for Academic Misconduct and Assessments Tutor and year 2 lead for BSc nursing students). Mary has taught pre- and post-registration nurses, nurse associates, midwives and paramedics.

She has held external examiner roles at Robert Gordon University, Aberdeen, and the University of Huddersfield, and was an active member of the RCN Children and Young People's Professional Interests Forum for 8 years and has contributed to several RCN publications. She was awarded a Teaching and Learning Fellowship by Kingston University in 2020.

Her most recent research studies have been regarding increasing mental health education for children's nursing students and regarding research productivity among academic staff in the university.

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Sarah is currently a Lecturer in Children's Nursing at the University of Hertfordshire, Hatfield, alongside her role as a Specialist Nurse in the Bone Marrow Transplant Unit at Great Ormond Street Hospital in London.

Sarah undertook their Children's Nursing Degree at Kings College London, giving them the opportunity to train within hospitals such as the Evelina London Children's Hospital and the Royal Brompton Hospital, in addition to spending time at the Alder Hey Children's Hospital in Liverpool, a specialist facility for childhood oncology. Once qualified, Sarah spent her first few years in the children's ward of the Royal Brompton Hospital, London. Leading on from her placement at Alder Hey, she felt her real interest lay within the specialty of childhood haematology and oncology. In 2014, Sarah began working at the Great Ormond Street Hospital, caring for and treating children undergoing allogeneic and autologous Hematopoietic Stem Cell Transplants. Due to Sarah's interest in the specialty, her career progressed to becoming a Specialist Nurse in Bone Marrow Transplant, a role that she continues to hold part-time alongside her role as a Lecturer. Sarah continues to be passionate about their work within clinical practice.

Sarah has always endeavoured to mentor and support student nurses whilst in practice. She realised that she particularly enjoyed sharing information, knowledge and good practice with others and decided to make the transition into teaching and academia.

Petra Brown, RN, DPSN, BSc (Hons) Critical Care, MA

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Petra began her nursing career in 1988 at Salisbury School of Nursing. She has worked in a variety of clinical areas, including post anaesthesia recovery, intensive and coronary care, community nursing and urgent integrated care. Following her attainment of degrees in critical care and education, she transitioned into academia, focusing on pre- and post-registration nursing and physician associate education. Her roles as a practice educator and lecturer at Bournemouth University underscore her commitment to nursing education. Currently, Petra contributes to the NHS integrated urgent care service in the UK, with a sustained interest in nurse education, advanced practice and service development.

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Ray Bywater is a highly accomplished sick children's nurse with over two decades of experience since qualifying in 1999. His extensive career includes working in children's wards in Enfield and Barnet, as well as two enriching years in the Channel Islands. Currently, Ray serves as the clinical manager of the children's community team in Barnet, where he leads a dedicated team in delivering exceptional care to children in the community.

Ray's commitment to the nursing profession is reflected in his academic and professional achievements. He holds a master's degree in nursing and is a Fellow of both Middlesex University and the University of Hertfordshire. As a Senior Lecturer at the University of Hertfordshire, he shares his expertise with the next generation of nurses, supported by his Postgraduate Certificate in Higher Education (PGCert) and recognition as a Fellow of the Higher Education Academy (FHEA).

In addition, Ray has the distinguished honour of being a Queen's Nurse, a title awarded for his dedication to patient care and leadership in the nursing community. His career is marked by a deep passion for paediatric nursing and education.

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Mary began her nursing career training in 1978 to become a State Registered Nurse at the Edgware General Hospital. On completion of training, she became a staff nurse in the Accident and Emergency Department at the Edgware General Hospital and later became a senior staff nurse in the children's ward at the same hospital. In 1986 she became an Industrial Nursing Officer, but returned to accident and emergency nursing in 1990. While working in the Accident and Emergency Department at the Barnet General Hospital, Mary studied for her second registration as a Registered Sick Children's Nurse, becoming an Accident and Emergency Sister and Paediatric Nurse Specialist in the same hospital. In 2001 she became a Nurse Facilitator for the North Central London Workforce Development Confederation and later went on to become the acting lead nurse for the cadet nursing scheme in the same NHS organisation. Mary worked as a lecturer in Child Health at the University of Hertfordshire from 2003, going on to become a senior lecturer, Alternate Professional Leader and Programme Field Tutor for Children's Nursing. From 2014 to 2018 Mary was also a Specialist Practice Advisor to the Care Quality Commission.

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Associate Director Academic Quality Assurance

Liz is a registered general and children's nurse. She has substantial clinical experience and worked as a clinical educator and lead nurse before becoming a Senior Lecturer at Middlesex University. From there Liz moved to the University of Hertfordshire and has just celebrated 20 years of service there. Liz has been involved in leading and developing pre-registration children's nursing modules and curricula. She has also led and developed post-registration programmes of education and was part of a central team who led the implementation of technology-enhanced assessments across the university. She actively provides mentorship to both internal and external colleagues. Liz has held substantial leadership roles including the Head of the Department.

Currently, Liz has a central role and is an Associate Director of Academic Quality Assurance. She leads the development and approval of higher and degree apprenticeship programmes within the university. She is a Senior Fellow of the Higher Education Academy. Liz is an external examiner and external verifier for other Higher Education providers. She is a Nursing and Midwifery Council Quality Assurance Agency assessor, an Office for Students assessor and has worked for some other regulators. Liz has authored and edited several books, chapters and papers. She is a peer reviewer for two journal publications. Her professional areas of interest are professional values, ethics in child health, safeguarding, work-based learning and regulation.

Dr Barry Hill

Dr Barry Hill is a Professor of Nursing and Head of the School of Nursing and Midwifery at Buckinghamshire New University, UK. A Senior Fellow of the Higher Education Academy (SFHEA), he actively mentors' colleagues within the HEA framework, supporting the development of teaching and learning.

With a background in intensive care nursing, Barry holds an MSc in Advanced Practice and is registered with the Nursing and Midwifery Council (NMC) as a registered nurse, registered teacher, and registered independent and supplementary prescriber. He has made significant contributions to nursing education and research, having published 9 books, over 80 book chapters, and over 100 peer-reviewed journal articles.

Barry is the Consultant Editor for the *International Journal for Advancing Practice* and the Clinical Editor for the *British Journal of Nursing*. His PhD focused on qualitative research, applying hermeneutic phenomenology and Max van Manen's framework to explore professional experiences in nursing.

Louise McLaughlin, RN (child), BSc (Hons), MSc, PG Cert, FHEA

Senior lecturer in Children's Nursing, School of Health and Social Work, University of Hertfordshire, Hatfield, UK

Louise McLaughlin has a keen interest in children's palliative care and has worked in children's hospices across the East of England for 15 years. This involved working in inpatient units, as well as outreach and symptom

management teams. It was during this time that she completed her MSc in Contemporary Nursing at the University of Hertfordshire in 2015. Louise left her role as a Children's Palliative Care Clinical Nurse Specialist in 2022 to pursue her passion for education. She is currently involved in the teaching and assessment of students studying the BSc (Hons) Children's Nursing and FdSC Nursing Associate programme at the University of Hertfordshire. Louise is involved in the delivery of a range of modules including practice, health promotion and anatomy and physiology. Having gained her non-medical prescribing qualification, she is also involved in the teaching of prescribing for children.

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Alison commenced her nursing career in London where she qualified as a registered nurse at St Thomas' Hospital, London, and a registered children's nurse at Great Ormond Street Hospital. She subsequently worked in paediatric respiratory intensive care before moving into nurse education in the School of Nursing at Great Ormond Street Hospital. Following a career break, she returned to clinical nursing working as a clinical nurse specialist in paediatric immunology nursing at the St George's Healthcare NHS Trust. In 2010 she returned to teaching in higher education at the University of Hertfordshire and currently works there as a visiting lecturer for the Children's Nursing programme.

Michele O'Grady, RGN, RSCN, MSc, PGcert
Michele O'Grady is a Senior Lecturer at the University of Hertfordshire. She trained in Dublin and worked as a qualified nurse until she went to Sudan with the voluntary agency GOAL, running a primary care programme. She moved to the UK in 1987 where she worked in several hospitals before moving to Oxford where she became an HIV Liaison Officer for five years. Michele returned to the NHS where she was a senior sister and an Emergency Nurse Practitioner in the Children's Emergency Department at the Watford General Hospital. Michele joined the child nursing lecturing team in 2015.

Michele has had an interest in sexual health and health promotion since her time in Sudan.

Joanne Outteridge, RN (Child), ENB 415, BN (Hons), PgDip Healthcare Ethics, PgDip HE, MSc
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Jo began her nursing career as a children's nurse at the Evelina Children's Hospital, London, working in paediatric cardiology and then paediatric intensive care units. She then moved to teaching children's pre-registration and respiratory nursing at City University, London, becoming a lecturer practitioner in the children's medical wards at the Royal London Hospital.

Jo now works at Anglia Ruskin University as the Director of Interprofessional Learning in the Faculty of Health, Medicine and Social Care, working with staff and students across all health courses to come together to learn about topics of shared interest. She teaches continuing professional development (CPD) activities related to children's high dependency care for children's nurses from NHS Trusts in Norfolk, Suffolk, Cambridgeshire and Essex, and assessing the unwell child for MSc Advanced Practitioner courses.

Dr Julia Petty, BSc Hons, RGN/RSCN, MSc, PGCE, MA, EdD
Julia is an adult, paediatric and neonatal nurse who worked as a practice educator at the Great Ormond Street Hospital before becoming a Senior Lecturer at City University, London, UK. There, she co-led the neonatal nursing education portfolio for 12 years before moving to the University of Hertfordshire (UH) in 2013. Currently, she is an Associate Professor (learning and teaching) and a Senior Lecturer in Children's Nursing. Julia leads a range of pre-registration children's nursing modules including curricula related to research, communication and neonatal care. She is a Principal Fellow of the Higher Education Academy and holds a National Teaching Fellowship award. Outside UH, Julia is an external examiner for other higher education institutions. She has recently worked clinically for the UK National Vaccination Programme, is a newborn life support instructor for the Resuscitation Council UK, a Trustee for the UK Neonatal Nurses Association and the Vice President of the Council of International Neonatal Nurses. She also teaches and mentors healthcare educators remotely, based in Africa and China, through Project HOPE charity. Julia has authored and edited a range of book, chapter and article publications. Her doctoral and post-doc research interests focus on parents' premature birth experiences, supporting parents in the transition home, preparation for parenting through simulation dolls and exploring the communication needs of neonates and their parents.

Sheila Roberts, RGN, RSCN, BA, MA
Sheila is currently a Senior Lecturer in Children's Nursing at the University of Hertfordshire, Hatfield, where her particular responsibilities are for selection and recruitment as well as being part of the team delivering the pre-registration nursing curriculum to student children's nurses, where her particular area of interest is anatomy and physiology. Sheila also has an interest in service-user involvement and has been involved in ensuring that the

voice of the child and young person is embedded in the pre-registration curriculum. Sheila has been involved in a range of research activities including the NHS England Youth Forum, looking at the role of RealCare dolls in the pre-registration curriculum and how to enhance resilience and self-efficacy in parents of children with disabilities and complex health needs. Before moving into education, Sheila trained as an RSCN/RN at the Queen Elizabeth School of Nursing, Birmingham, working at Birmingham Children's Hospital before holding a variety of posts within acute paediatric care across the Midlands and the East of England.

Dr Lisa Whiting, DHRes, MSc., BA (Hons), RGN, RSCN, RNT, LTCL

Dr Lisa Whiting is an Associate Dean Research and Associate Professor (Research), School of Health and Social Work at the University of Hertfordshire. Lisa worked within a paediatric critical care setting for several years before moving to a university environment; she has been involved in the teaching and assessment of undergraduate and postgraduate students across a range of academic levels, including doctoral studies. Lisa has led several research projects that have spanned a range of child health issues and that have had a strong focus on the involvement of, and the voice of, children, young people and their families. Other research has had an educational remit and has centred on the enhancement of learning for nurses working within areas of child health and children's nursing. Current and recent projects include: *An evaluation of the safeguarding training delivered to frontline staff*; *The components of different staffing models that improve nurse and patient outcomes in critical care*; *Gaining insight into food, diet practices and nutrition during the early year's lifespan*; *The experiences of student nurses during and post pandemic*; *Exploring neonatal nurses' and parents' understanding of factors that enhance and hinder communication*. She has disseminated her work widely.

Preface

This third edition of the highly regarded *Fundamentals of Children and Young People's Anatomy and Physiology – For Nursing and Healthcare Students* has been updated to ensure contemporary content reflecting the anatomy and physiology of children and young people. Feedback from readers has inspired significant revisions, ensuring the content remains current and evidence-based, with its focus on children and young people in all aspects.

Maintaining its user-friendly features, this edition continues to use clear, full-colour illustrations to enhance learning, retention and practical application. Nurses delivering safe and effective family-centred care must understand the unique anatomical and physiological characteristics of children and young people, as their developmental stages and dynamic physiology differ from adults.

The text emphasises that children are not simply smaller versions of adults. Their bodies are in continuous development, making their physiology particularly vulnerable during growth and organ maturation. Nurses must address the holistic needs of their patients, recognising the structural and functional intricacies of the human body across different levels. The new edition emphasises further, the importance of child development.

Effective nursing care for children and young people requires a comprehensive understanding of their unique anatomy and physiology. This textbook aims to equip students with the fundamental knowledge needed to develop practical skills and provide compassionate, skilled nursing care across various settings. As children grow and develop, their immature systems influence disease processes as well as therapeutic responses.

The third edition of this textbook integrates evidence-based theory with practice, highlighting the importance of understanding the anatomical and physiological aspects that are critical to effective healthcare. Expert nurses have crafted the chapters for you to serve as a valuable reference in practice placements, classrooms and at home.

The Nursing and Midwifery Council sets standards for nursing education and practice. This text aligns with those standards, helping students demonstrate proficiency in anatomy and physiology, ensuring they are fit to practice upon registration. Knowledge of biological sciences is crucial for safe, effective nursing care, emphasising a holistic approach to healthcare.

This edition has retained its original spirit, ensuring a reader-friendly experience. Each chapter begins with learning outcomes, including case studies, review questions and activities to reinforce learning and retention.

There are 20 chapters, and the majority are focused on body systems; this edition introduces a new chapter on the complex language of anatomy and physiology. The final chapter discusses how social, political and environmental factors influence health, contextualising the care of children and young people.

We are delighted to present this third edition and hope it aids you in the provision of exceptional care to children, young people and their families.

Ian Peate
London
Elizabeth Gormley-Fleming
Hertfordshire

Acknowledgements

Ian would like to thank his partner Jussi Lahtinen for his ongoing support. Liz would like to thank her husband Kieran and her daughters Kate and Eilis for their support and wise words. We are indebted to the amazing contributors who once again have been willing to share their insight, knowledge and wisdom. We also thank Tom Marriott and Christabel Daniel Raj at Wiley for their support.

About the companion website

Don’t forget to visit the companion website for this book:

www.wiley.com/go/childrensanatomy3e

There you will find valuable material designed to enhance your learning, including:

- Interactive multiple-choice questions
- ‘Label the diagram’ flashcards
- Searchable glossary

Scan this QR code to visit the companion website:

CHAPTER 1

Learning the language: terminology

Ian Peate[1] and Elizabeth Gormley-Fleming[2]

[1]*Editor in Chief British Journal of Nursing*
[2]*Centre for Academic Quality Assurance, University of Hertfordshire, Hatfield, UK*

AIM

The aim of this chapter is to provide insight and understanding concerning the terminology related to the anatomy and physiology in caring for the child and young person.

LEARNING OUTCOMES

On completion of this chapter, the reader will be able to:

1. Discuss the terms anatomy and physiology.
2. Further understand prefixes and suffixes used in anatomy and physiology.
3. Understand directional terms and describe the anatomical planes, anatomical regions of the body and the body cavities.
4. Apply the anatomical physiological concepts to patient care.

Test your prior knowledge

1. What do you understand by the terms anatomy and physiology?
2. Why is understanding anatomy and physiology important for nurses?
3. What is the difference between a sign and a symptom?
4. How is the root word altered by a prefix or a suffix?
5. Long bones have several important landmarks or structural features, what are they?

Fundamentals of Children and Young People's Anatomy and Physiology: For Nursing and Healthcare Students, Third Edition.
Edited by Ian Peate and Elizabeth Gormley-Fleming.

Companion website: www.wiley.com/go/childrensanatomy3e

Introduction

Science, particularly those terms used in the provision of health care, is full of Latin and Greek terminologies. For all parts of the body, Latin names are used: Greek terms are also common. Nurses and other health and care staff use anatomical and physiological concepts as they work with people who they offer care to, as they offer treatment to those who are experiencing some type of health condition or disease.

Clinical application

Like any country with its own language, the field of children's and young people's nursing also has its own language. This language is important to ensure communication between healthcare professionals can take place quickly and efficiently without the need for too much explanation. It is a specific language that is not only used by nurses, midwives, paramedics, doctors and others who are actively involved in the medical arena but it is important for all those who work in the healthcare arena, for example, pharmacists, physiologists and dentists. Its correct use can have a considerable impact on providing the best care experience.

Anatomy and physiology

Anatomy is the study of the structure and location of body parts, and physiology is the study of the function of body parts; both terms are interlinked. Understanding where the body parts are located can help understand how they function. McGuiness (2018) explains that when thinking of the various functions of the heart and the four chambers along with the valves, this is the anatomy, and visualising these many structures can assist in understanding how blood flows through the heart and how the heart beats, this is related to its function and as such its physiology.

Anatomy

The body map

Learning anatomical terminology is like learning a new language. When your learning has developed and you understand more and you add different terms to your vocabulary, this can help you talk confidently and competently about the body. The anatomical directional terms and body planes present a universally recognised language of anatomy. When undertaking the study of anatomy and physiology, it is essential that you use key or directional terminology so that you can give precise description as you or others refer to the precise location of a body part or structure.

Special considerations

When you are next on placement, identify how many times you hear clinicians describe and discuss the anatomy, physiology and pathophysiology of a child or young person. Note the terminology used and how between the team there is a clearer understanding when using one language – anatomical and physiological terminology.

Now think of a child or young person with a learning disability and how they may be feeling when all this terminology is being used in front of them. How might the parents/carers be feeling?

Whilst you are encouraged to use the correct anatomical and physiological approach when conversing with other colleagues, exercise caution when speaking in front of and with children, young people and their families. Nurses can inadvertently use words and jargon that are strange to patients and families, some concepts are familiar and obvious to nurses. However, they may be alien to those they offer care to.

First, try to establish what the person knows and understands before launching into a discussion that begins at a level that is either too complex or too simple. Too often, healthcare environments fail to recognise the needs of people with different levels of understanding about their health. This may mean that people may fail to receive the right care at the right time.

Using jargon can instil fear, cause confusion and result in poor care. How can you, as the patient's advocate, help ensure they understand the discussions that are going on around them?

All parts of the body are described in relation to other body parts and a standardised body position known as the anatomical position is used in anatomical terminology. An anatomical position is established from an imaginary central line that runs down the centre or midline of the body. When, in this position, the body is erect, it faces forwards, with the arms to the side, palms face forwards with the thumbs facing outwards and the feet are slightly apart with the toes pointing forwards.

The standard body 'map' or anatomical position (just like a map) is that of the body standing upright (orientated with the north at the top), with the feet at shoulder width and parallel, toes forward (see Figure 1.1), humans are usually bilaterally symmetrical. This anatomical position is used to describe body parts and positions of people irrespective if they are lying down (supine), lying on their side (lateral) or facing down (prone).

As well as understanding the anatomy and the physiology (the structure and function), understanding directional terms and the position of the various structures is also required. Table 1.1 lists common anatomical descriptive terms you will need to know.

See Figure 1.2. Depicts anatomical directions.

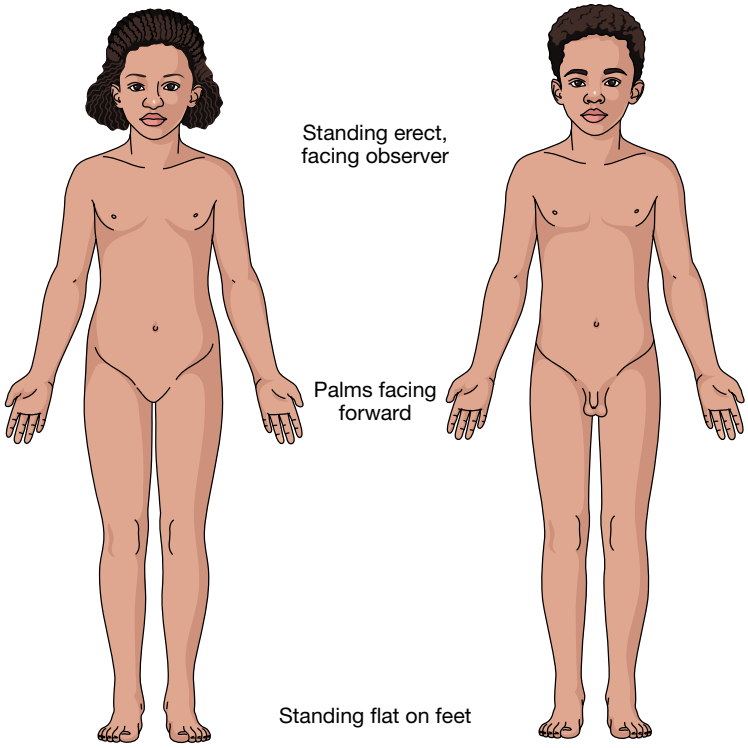

FIGURE 1.1 Anatomical position: anterior view of the body.
Source: Peate Applied Pathophysiology 4e Page 3 Fig 1.1/John Wiley and Sons.

TABLE 1.1 **Anatomical descriptive terms.**

Anatomical term	Relationship to the body
Anterior	Front surface of the body or structure
Posterior	Back surface of the body or structure
Deep	Further from the surface
Superficial	Close to the surface
Internal	Nearer the inside
External	Nearer the outside
Lateral	Away from the mid-line
Median	Midline of the body
Medial	In the direction of the mid-line
Superior	Located above or towards the upper part
Inferior	Located below or towards the lower part
Proximal	Nearest to the point of reference
Distal	Furthest away from the point of reference
Prone	Lying face down in a horizontal position
Supine	Lying face up in a horizontal position

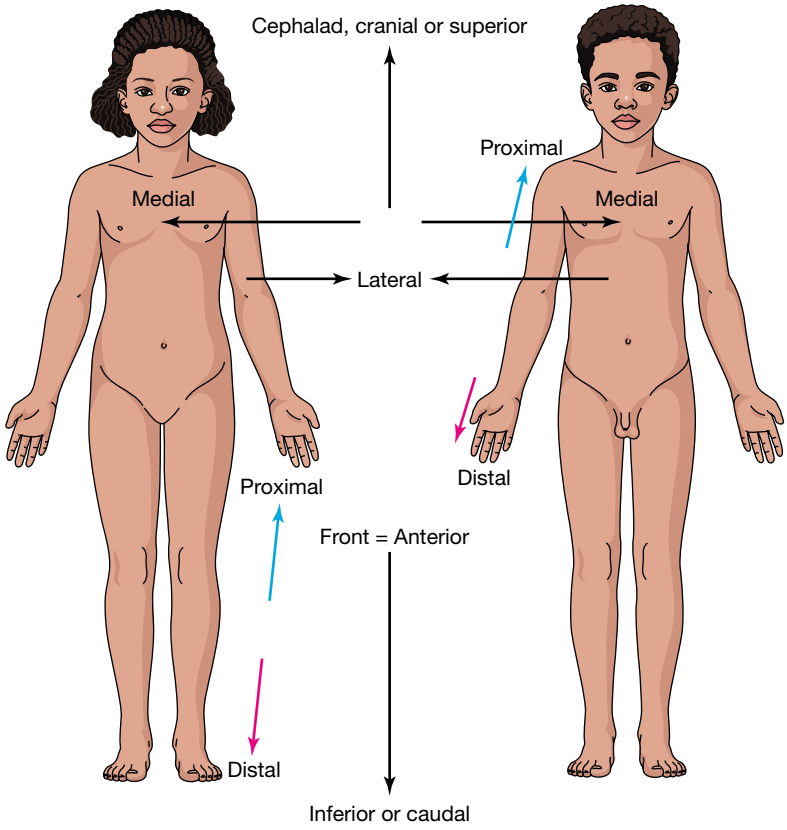

FIGURE 1.2 Anatomical directions.
Source: Peate Applied Pathophysiology 4e Page 4 Fig 1.2/John Wiley and Sons.

Case study

You are working in an emergency department at a large city hospital and caring for Candisha, an 8-year-old child who is attending the department with her mother and twin sister.

Candisha has been brought to the hospital with severe abdominal pain, complaining of abdominal pain for past 24 hours. Initially, her mother thought it might be gastroenteritis (several children at Candisha's school had gastroenteritis), when the pain persisted and Candisha developed a fever, mother decided to seek medical attention.

Initial Examination: Upon arrival at the hospital, Candisha was seen by a children's nurse who triaged her. The following observations were made:
Temperature: 38.6°C (tympanic)
Heart Rate: 110 beats per minute
Blood Pressure: 100/70 mm Hg
Respiratory Rate: 20 breaths per minute
Abdominal Examination: Tender and painful in the right lower quadrant
Oxygen Saturation: 98% (on air)
Pain Score: 8 using visual analogue score

Patient assessment

General appearance

Candisha looked tired and uncomfortable and appeared lethargic. She was keeping still and crying. Mother reported she seemed paler than usual and compared how much paler Candisha looked to her sister.

Systematic approach

On examination

The sclera were inspected. Paleness in the conjunctiva was noticed as a lighter or more translucent appearance.

A capillary refill test was performed. A slower capillary refill time was noted (longer than 2 seconds) indicating poor circulation associated with paleness.