

FUNDAMENTALS

FOURTH EDITION

Fundamentals of **Applied Pathophysiology**

An Essential Guide for Nursing & Healthcare Students

EDITED BY
IAN PEATE

Mapped to
the 2018 NMC
Standards



WILEY Blackwell

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Applied Pathophysiology

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EDITED BY

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*This text is dedicated to my late sister,
Maureen Ann Paterson (nee Peate).*

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Preface

The fourth edition

Being in a position to write the preface for the fourth edition of *Fundamentals of Applied Pathophysiology: An Essential Guide for Healthcare Students* is an absolute privilege. We have listened to feedback from a wide range of sources. This edition brings with it a number of changes; however, we have tried to retain the user-friendly approach that readers tell us they enjoy.

I have introduced a series of new activities, including website activities, that are intended to help you learn in an engaged way and to apply your learning when you are in the care setting, wherever this may be. This edition has been updated; the pathophysiology and important issues related to care have been reviewed. The illustrations are there to assist in understanding and appreciating the complex conditions that are being discussed. By using a fundamental approach to the subject, this can help readers acquire a key understanding of applied pathophysiology.

This edition retains its nursing and healthcare focus and considers the wider context of care provision. An essential requirement for those who offer care and support to people in contemporary care environments is an integrated, multidisciplinary approach. The healthcare student is an important participant within the multidisciplinary care team. In this book, a multidisciplinary approach is acknowledged as well as the recognition that care is delivered in dynamic environments to a diverse groups of people and communities.

This text has been written with the intention of making the subject of pathophysiology understandable and stimulating. Our bodies have astonishing capacity as they respond to illness in a number of physiological and psychological ways; we are able to compensate for the changes that occur as result of the disease process, the pathophysiological processes and the impact they can have on a person. This text can help in developing critical thinking, encouraging innovation and creativity in relation to the health and well-being of the people that you have the privilege to care for.

New features have been added, along with two new chapters: *Learning the Language* and *Homeostasis*. These two chapters are provided earlier on in the text so as to help prepare the reader for some of the more complex discussions to follow. Each chapter concludes with questions that aim to trigger reflection and encourage further thought. In the snapshots (case studies), pseudonyms are used to maintain confidentiality. Nurses and those who offer care owe a duty of confidentiality to all those they care for (Nursing and Midwifery Council, 2018).

Where appropriate, we have included boxed information that will help you when you are providing care. Red flags are incorporated that contain significant information alerting you to be cautious in your approach, and orange flags alert the reader to psychological considerations and also information regarding the management of medicines as related to the chapter.

The snapshots have been developed further and usually include data concerning the patient's vital signs and blood analysis. This can help relate important concepts to care, offering more insight into the patient's condition and therefore needs. Some of the snapshots include a NEWS2 score (national early warning score) where applicable (Royal College of Physicians, 2017).

Many of the values cited are a range, and blood pressure in respect of the NEWS2 score is noted as systolic. Local policy and procedure should be adhered to when using NEWS2.

Although an elevated blood pressure is an important risk factor for cardiovascular disease, it is low or falling systolic blood pressure that is most significant in the context of assessing acute illness severity. We have adopted the Royal College of Physician's (2017) stance on this parameter related to a range of systolic blood pressure.

Each chapter provides questions that are there to test your pre- and post-knowledge. There are a range of self text multiple choice questions at the end of each chapter. Selected chapters provide a list of further resources that the reader may wish to access in order to increase and advance learning.

Pathophysiology considers the cellular and organ changes that occur when disease is present, as well as the effects these changes have on the ability to function. When something interrupts normal physiological functioning, such as illness, this then becomes a pathophysiological issue. It must always be remembered that normal health is not and can never be exactly the same in any two people, and as such the term *normal* has to be treated with caution. An understanding of pathophysiology 'normal' and 'abnormal' can assist the student help the patient in a competent, compassionate safe and effective manner.

This text is a foundation text that can help the reader grow personally and professionally with regards to the provision of care, and is primarily intended for nursing students who come into contact with those who may have a number of physical healthcare problems, in the hospital and community setting. The text focuses on the adult person. Illness and disease are discussed explicitly, highlighting the fact that people do become ill and they do experience disease.

You need not read the text from cover to cover, you are encouraged to dip in and out of it. The aim is to entice and encourage you, whet the appetite, so you may read further, and in so doing we hope to instil a sense of curiosity in you. The first six chapters set the scene, and you may want to think about reading these first and then move on to a more specific area of interest.

We have enjoyed putting this new edition together, and we truly hope that you enjoy reading it and applying it to practice situations.

Ian Peate
Gibraltar
March 2021

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- Royal College of Physicians (2017). *National Early Warning Score (NEWS) 2 standardising the assessment of acute illness severity in the NHS* <https://www.rcplondon.ac.uk/projects/outputs/national-early-warning-score-news-2> last accessed January 2021.

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I would like to thank my partner, Jussi Lahtinen, for his support and encouragement and my dear friend Mrs Frances Cohen.

Thank you to all of my colleagues, who have been so supportive in providing their expertise and time contributing to this new edition of this well-established text.

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About the companion website

This book is accompanied by a companion website:

www.wiley.com/go/fundamentalsofappliedpathophysiology/student4e

The student website includes:

- Interactive multiple choice questions
- Interactive true/false exercises
- Searchable glossary
- Further reading and resources

The instructor website includes:

www.wiley.com/go/fundamentalsofappliedpathophysiology/instructor4e

- Image Bank
- PowerPoint slides

Chapter 1

Learning the language: Terminology

Ian Peate

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hints and tips	15		

Key words

- Terminology
- Anatomy
- Physiology
- Pathophysiology
- Latin
- Greek
- Prefix
- Suffix
- Word roots
- Forms

Test your prior knowledge

- What do you understand by the term *prefix*?
- What do you understand by the term *suffix*?
- How is the root word altered by a prefix or a suffix?
- List the anatomical planes.

Learning outcomes

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

- Discuss the terms *anatomy*, *physiology* and *pathophysiology*
- Further understand prefixes and suffixes used in anatomy, physiology and pathophysiology
- Understand directional terms
- Describe the anatomical planes, anatomical regions of the body and the body cavities



Don't forget to visit the companion website for this book

(www.wiley.com/go/fundamentalsofappliedpathophysiology/student4e) where you can find self-assessment tests to check your progress, as well as lots of activities to practise your learning.

Introduction

The terms used in science, especially in nursing and medicine, are saturated with Latin and Greek terminology. Latin names are used for every part of the body, and Greek terms are common since the Greeks are said to be the founders of modern medicine. All healthcare professionals use pathophysiology as they work with the people whom they offer care to and offer treatment for those who are experiencing some type of health condition.

Anatomy and physiology

Anatomy is concerned with the study of the structure and location of body parts, and physiology is the study of the function body parts; these two terms are interlinked. Knowing where the body parts are located can help you understand how they function. McGuiness (2010) explains that thinking of the numerous functions of the heart and the four chambers along with the valves (this is the anatomy) and visualising these various structures can help in comprehending how blood flows through the heart and how the heart beats (this is related to its function and therefore its physiology).

Anatomy

The body map

Learning anatomical terminology is like learning a new language and can help you talk confidently about the body; the anatomical directional terms and body planes present a

universally recognised anatomical language. When undertaking the study of anatomy and physiology, it is essential that you have a key or directional terminology in order to give you an accurate description as you or others refer to the precise location of a body part or structure.

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 line that runs down the centre or mid-line of the body. When in this position, the body is erect and faces forward with the arms to the side, the palms face forward with the thumbs to the side and the feet are slightly apart with the toes pointing forward.

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

As well as understanding the anatomy and the physiology (the structure and function), understanding directional terms and the positions of the various structures is also necessary. Table 1.1 lists common anatomical descriptive terms that you will need to become acquainted with.

Figure 1.2 depicts anatomical positions.

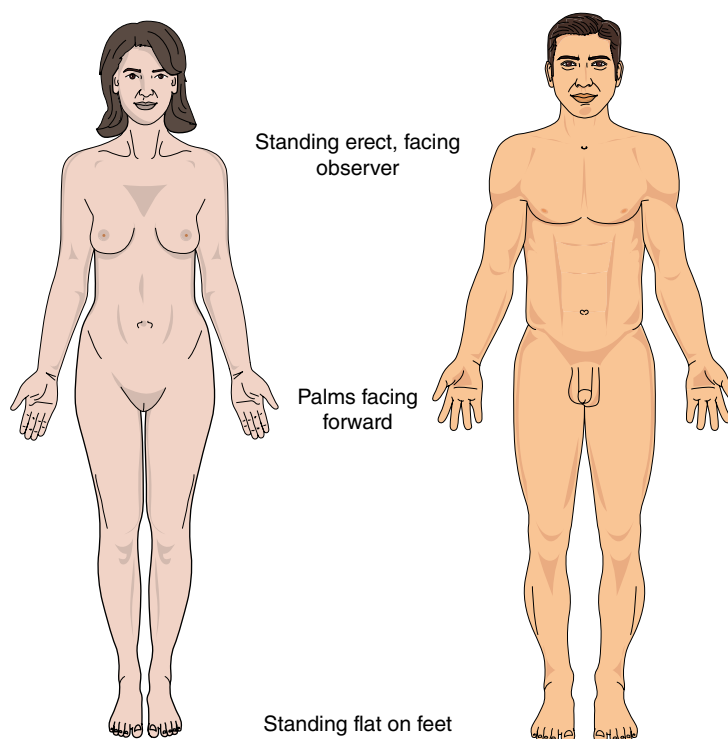


Figure 1.1 Standard anatomical position.

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	Mid-line 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

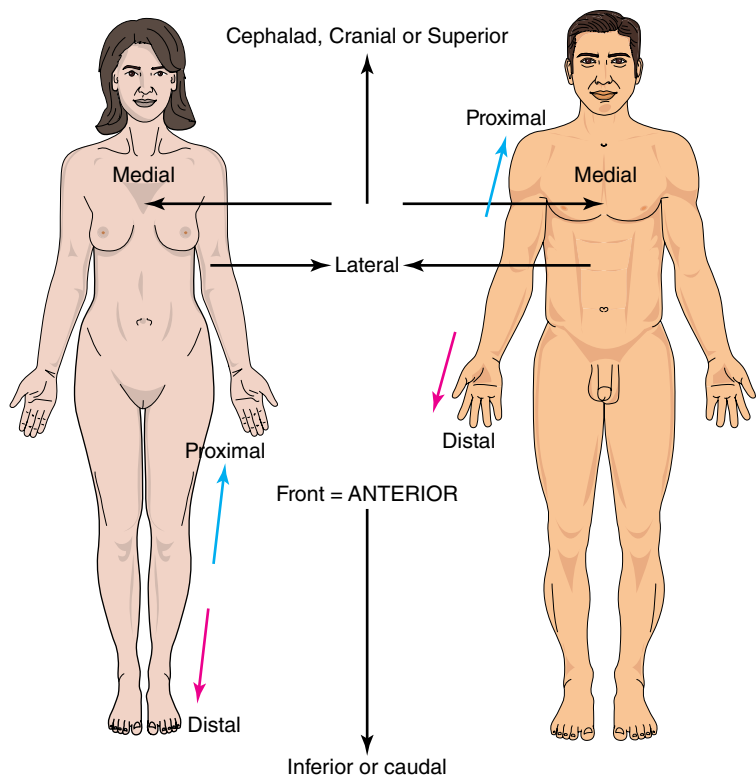


Figure 1.2 Directional anatomical positions.

Anatomical planes of the body

A plane is an imaginary two-dimensional surface that passes through the body. There are three planes that are generally referred to in anatomy and healthcare (see Figure 1.3):

- Sagittal
- Frontal
- Transverse

The sagittal plane, the vertical plane, is the plane that divides the body or an organ vertically into the right and left sides. If this vertical plane runs directly down the middle of the body, it is known as the midsagittal, or median, plane. If it divides the body into unequal right and left sides, then it is called a parasagittal plane.

The frontal plane is the plane dividing the body or an organ into an anterior portion and a posterior portion. The frontal plane is often referred to as a coronal plane (the word *corona* is Latin for 'crown').

The transverse plane divides the body or organ horizontally into the upper (superior) and lower (inferior) portions.

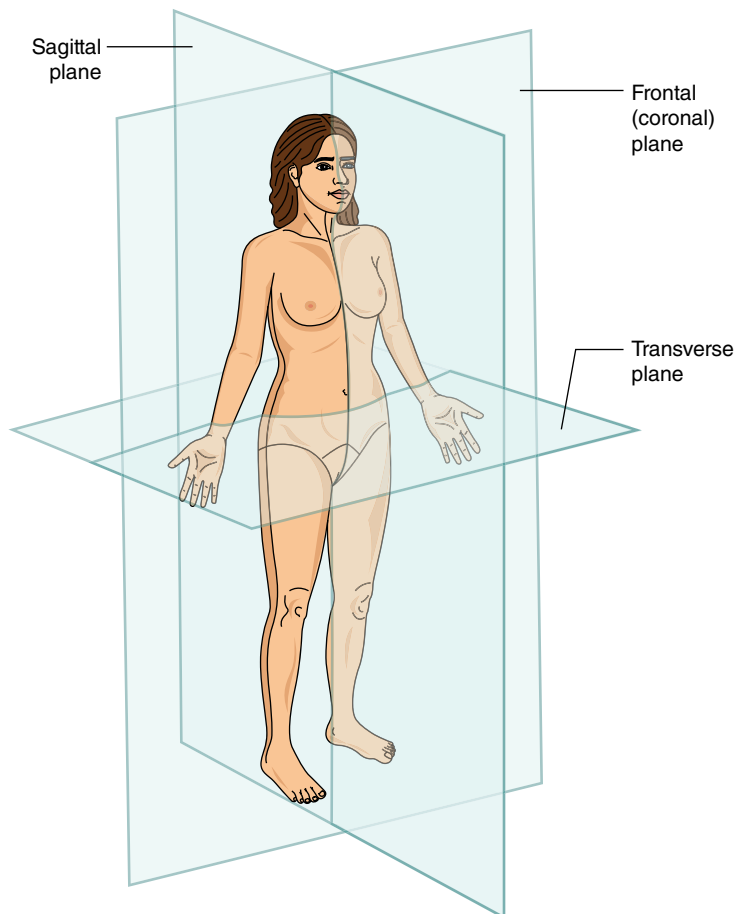


Figure 1.3 Anatomical planes.

Anatomical regions of the body

6

The body is divided up into regions, like a map, and the anatomical regions of the body refer to a particular area/region of the body, which helps to compartmentalise the body. The body is divided into the following:

- Head and neck
- Trunk (thorax and abdomen)
- Upper limbs (arms)
- Lower limbs (legs).

Tables 1.2, 1.3, 1.4, and 1.5 present the correct terminology for each region.

Body cavities

Body cavities are spaces within the body that contain the internal organs. The cavity can be filled with air or with organs. Minor body cavities include the oral cavity (mouth), the nasal

Table 1.2 Anatomical regions of the head and neck.

Anatomical term	Area of body related to
Cephalic	Head
Cervical	Neck
Cranial	Skull
Frontal	Forehead
Occipital	Back of head
Ophthalmic	Eyes
Oral	Mouth
Nasal	Nose

Table 1.3 Anatomical regions of the trunk (thorax and abdomen).

Anatomical term	Area of body related to
Axillary	Armpit
Costal	Ribs
Mammary	Breast
Pectoral	Chest
Vertebral	Backbone
Abdominal	Abdomen
Gluteal	Buttocks
Inguinal	Groin
Lumbar	Lower back
Pelvic	Pelvis/lower part of abdomen
Umbilical	Navel
Perineal	Between anus and external genitalia
Pubic	Pubis

Table 1.4 Anatomical regions of the upper limbs.

Anatomical term	Area of body related to
Brachial	Upper arm
Carpal	Wrist
Cubital	Elbow
Forearm	Lower arm
Palmar	Palm
Digital	Fingers (also relates to toes)

Table 1.5 Anatomical regions of the lower limbs (legs).

Anatomical term	Area of body related to
Femoral	Thigh
Patellar	Front of knee
Pedal	Foot
Plantar	Sole of foot
Popliteal	Hollow behind knee
Digital	Toes (also relates to fingers)

cavity, the orbital cavity (eye), middle ear cavity and the synovial cavities (these are spaces within the synovial joints).

There are two main cavities in the body:

1. The dorsal cavity is located in the posterior region of the body.
2. The ventral body cavity occupies the anterior region of the trunk.

The dorsal cavity is subdivided into two cavities:

1. Cranial cavity: Encloses the brain and is protected by the cranium (skull)
2. Vertebral/spinal cavity: Contains the spinal cord and is protected by the vertebrae

The ventral cavity is subdivided into the following:

1. The thoracic cavity: It is surrounded by the ribs and muscles, the intercostal muscles. The thoracic cavity contains the lungs, heart, trachea, oesophagus and thymus. It is separated from the abdominal cavity by the diaphragm.

The abdominopelvic cavity:

- a. The abdominal cavity: Contains the stomach, spleen, liver, gallbladder, pancreas, small intestine and most of the large intestine. The abdominal cavity is protected by the muscles of the abdominal wall and partly by the diaphragm and ribcage
- b. The abdominopelvic cavity: Contains the urinary bladder, some of the reproductive organs and the rectum

The pelvic cavity is protected by the bones of the pelvis.

Figure 1.4 depicts the body cavities.

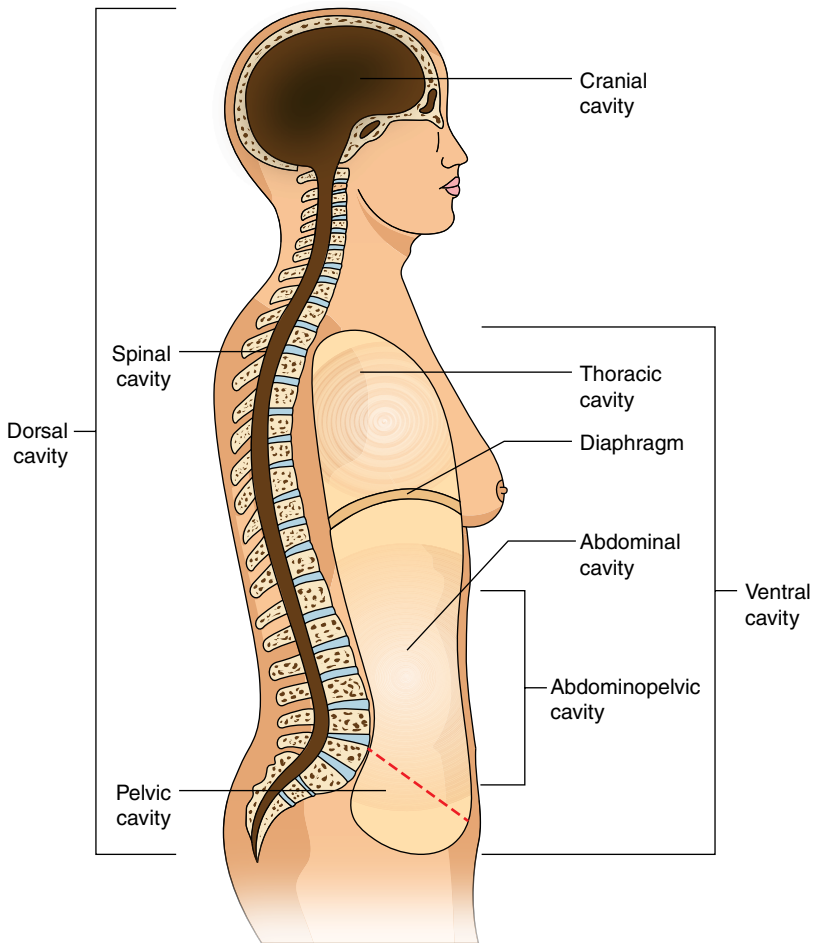


Figure 1.4 The cavities of the body.

Physiology

Human physiology concerns itself with the study of the body's function. Anatomy and physiology therefore are the study of the structure and the function of the human body, respectively.

The human body is organised in a most precise way whereby atoms combine in appropriate ways forming molecules in the chemical organisation of the body. The molecules combine to form cells and cells organise themselves collectively as functioning masses that are known as tissues and then organs and systems. Chapter 2 of this text describes cells and the organisation of tissues within the body

Terminology

Already in this chapter you may have come across some complex terms. It is important to learn the language (the terminology) that is used in the provision of healthcare; this is an important part of safe and effective care. Whilst it is not a pre-course requirement to be proficient in Latin or Greek in order to learn anatomical terminology to become a nurse or healthcare practitioner, it is essential that you understand and are able to use the terminology.

There are three basic parts associated with medical terms; see Table 1.6.

The word *root* is the core of the word and provides the basic meaning to the subject of the word; the prefixes and the suffixes modify the word. In the word *hepatitis*, for example, the word root is *hepa*, which means liver. When the suffix 'itis' ('itis' means inflammation) is added, then this changes the word root, and it becomes *hepatitis* – inflammation of the liver.

Word roots act as the foundation for most medical terms and often (but not always) describe the part of the body that is involved (see Figure 1.5).

Table 1.6 Basic components.

Component	Description
Word root	This is usually found in the middle of the word and is its central meaning
Prefix	The prefix comes at the beginning of the word and usually identifies some subdivision or part of the central meaning
Suffix	This comes at the end of the word and modifies the central meaning as to what or who is interacting with it or what is happening to it

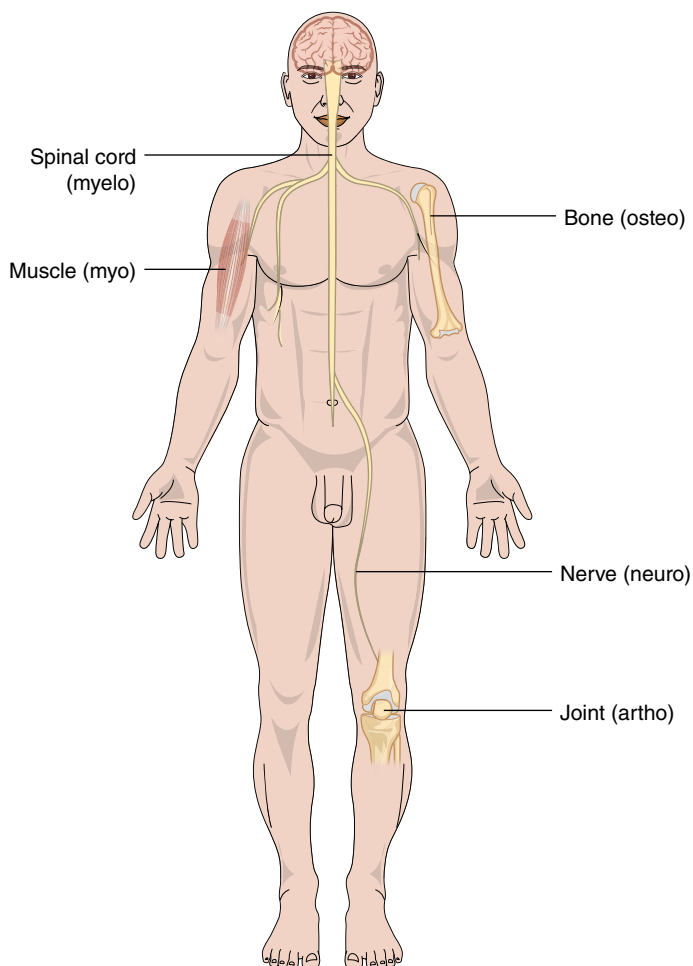
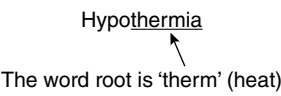


Figure 1.5 Word roots are the foundation of most medical terms and describe the part of the body involved.

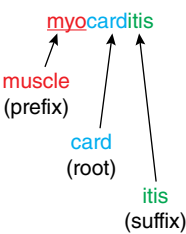
The prefix is added to the beginning of the word root and also changes the meaning of the word. If the root word is *nutrition* and the prefix ‘mal’ is added (this means bad), then *malnutrition* means bad or poor nutrition.

Look at this example:



‘Hypo’ means low (this is the prefix)
Hypothermia = low heat

Take a look at this word:
myocarditis
Now let us break this up:



myo	card	itis	Inflammation of heart muscle
Muscle	Heart	Inflammation	

The prefix can change the word:

- Myocarditis = inflammation of heart muscle
- Endocarditis = inflammation of the inner layer of the heart
- Pericarditis = inflammation of the outer layer of the heart

The suffix can also alter the word:

- Cardiologist = a practitioner specialising in the heart
- Cardiomyopathy = damage to heart muscle
- Cardiomegaly = enlargement of the heart

In these examples, the prefix and suffix can change the meaning of the word but, the root *cardio* stays the same.

There are many frequently used prefixes and suffixes, and you will already know some of them. See Table 1.7 for a list of some prefixes and suffixes that are used in a number of medical terms.

As is the case when learning any language, it can take time to learn all the words, and indeed, the learning may be lifelong. When you are in practice, you will be able to reinforce your learning, using your new vocabulary with confidence. Take your time, seek clarification if needed and be patient with yourself.

Knowing the various anatomical terms can make it easier to understand the various pathophysiological concepts that can help you provide care that is patient centred, safe and effective.

Table 1.7 Some prefixes, suffixes, their meaning and examples.

Prefix/suffix	Meaning	Example
a/an	No, not, without, lack of	Anoxia (without oxygen), anuria (without urine), asepsis (without sepsis), asymptomatic (without symptoms)
ab	Away from	Abduction (to move away from the mid-line), abnormal (away from normal)
ad	Towards	Adduction (to move towards the mid-line), adrenal (towards the kidney), addiction (drawn towards or a strong dependence on a drug or substance)
aemia	Of blood	Leukaemia (cancer of blood cells), anaemia (lack of red blood cells)
algia	Pain	Cephalgia (headache), mastalgia (breast pain), myalgia (muscle pain)
ante	Before/in front of	Antepartum (before birth), anterior (to the front of the body), antepandial (before meals)
arthro	Joint	Arthroscope (an instrument used to look into a joint), arthritis (joint inflammation), arthrotomy (incision of a joint)
baro	Pressure/weight	Isobaric (having equal measure of pressure), bariatrics (the field of medicine that offers treatment to people who are overweight), baroreceptor (a sensor reacting to pressure changes)
brady	Slow/delayed	Bradycardia (slow heart rate), bradykinesia (slowness in movement), bradylalia (abnormally slow speech)
cyto	Cell	Leucocyte (white blood cell), erythrocyte (red cell), cytology (study and function of cells)
derm	Skin	Dermatitis (inflammation of the skin), dermatome (a surgical instrument used for cutting slices of the skin), dermatology (the study of skin)
dys	Difficulty/impaired	Dysphasia (difficulty swallowing), dyspepsia (disordered digestion), dysuria (difficulty in urination)
ectomy	To cut out	Appendectomy (removal of the appendix), mastectomy (removal of the breast), prostatectomy (removal of the prostate)
endo	Inner	Endocardium (lining of the heart), endocarditis (inflammation of the heart), endotracheal (within the trachea)
erythro	Red	Erythrocyte (red blood cell), erythropania (reduction in the number of red blood cells), erythema (reddening of the skin)
haem	Blood	Haematogenesis (the formation of blood), haematology (the study of blood), haemarthrosis (bleeding within the joint)
hydro	Water	Hydrophobia (abnormal dread of water), hydrocephalus (accumulation of fluid within the cranium)
hyper	Above/beyond/excessive	Hypertension (high blood pressure), hyperflexion (movement of a muscle beyond its normal limit), hyperglycaemia (high blood glucose)
hypo	Below/under/deficient	Hypotension (low blood pressure), hypothermia (low temperature), hypoglycaemia (low blood glucose)
intra	Within	Intravenous (within the veins), intraocular (within the eye), intracerebral (within the brain)
ism	Condition/disease	Hirsutism (heavy/abnormal growth of hair), hyperthyroidism (overactivity of the thyroid gland)
itis	Inflammation	Appendicitis (inflammation of the appendix), mastitis (inflammation of the breast), myocarditis (inflammation of heart muscle)
macro	Large	Macroscopic (large enough to be seen with the naked eye), macrocytic (an abnormally large cell), macroglossia (an abnormally large tongue)

(Continued)

Table 1.7 (Continued)

Prefix/suffix	Meaning	Example
mega/megaly	Enlarged	Cardiomegaly (enlarged heart), splenomegaly (enlarged spleen), hepatomegaly (enlarged liver)
micro	Small	Microscopic (so small can only be seen with a microscope), microcephaly (small brain), microsomia (small body)
myo	Muscle	Myocardium (heart muscle), myocyte (muscle cell), myometrium (uterine muscle)
neo	New	Neonate (new born), neoplasm (new growth [tumour]),
nephro	Kidney	Nephritis (inflammation of the kidneys), nephrostomy (an incision made into the kidney)
neuro	Nerve	Neuroma (a tumour growing from a nerve), neuralgia (pain felt along the length of a nerve), neuritis (inflammation of a nerve)
ology	Study of	Dermatology (study of the skin), neurology (study of the nervous system), cardiology (study of the heart)
oma	Tumour (swelling)	Melanoma (a cancer of melanocytes), carcinoma (a type of cancer), retinoblastoma (tumour of the eye)
ophth	Eye	Ophthalmology (study of the eye), ophthalmoscope (an instrument used to examine the inside of the eye), ophthalmotomy (an incision made into the eye)
osteo	Bone	Osteomyelitis (bone infection), osteosarcoma (bone cancer), osteoarthritis (inflammation of the joints)
ostomy	To make an opening (a mouth)	Colostomy (an opening into the colon), jejunostomy (an opening into the jejunum)
otomy	To cut into	Tracheotomy (cutting into the trachea), craniotomy (a hole made into the skull), thoracotomy (cutting into the chest)
oto	Ear	Otology (study of the ear), otosclerosis (abnormal bone growth inside the ear)
para	Beside/alongside	Parathyroid (adjacent to the thyroid), paraumbilical (alongside the umbilicus)
patho	Disease	Neuropathy (disease of the nervous system), nephropathy (disease of the kidney), retinopathy (disease of the retina)
penia	Deficiency	Leucopenia (deficiency of white cells), thrombocytopenia (deficiency of thrombocytes)
peri	Around	Pericardium, (the serous membrane around the heart) periosteum, (a covering enveloping the bones), peritoneum (the serous membrane lining the walls of the abdominal and pelvic cavities)
plasm	Substance	Plasma (liquid part of blood and lymphatic fluid), cytoplasm (substance of a cell lying outside of the nucleus)
plasty	Repair	Arthroplasty (surgical repair or replacement of a joint), myoplasty (muscle surgical repair of a muscle)
pneumo	Breathing/air	Pneumonia (a type of chest infection), pneumothorax (a collapsed lung), pneumograph (a device used for recording respiratory movement)
poly	Many/much	Polycystic (many cysts), polyuria (much urine), polyarthritis (arthritis affecting more than four joints)
rhino	Nose	Rhinitis (inflammation of the mucous membrane of the nose), rhinoplasty (surgical repair of the nose)
rrhoea	Discharge	Diarrhoea (frequently discharged faeces), rhinorrhoea (excessive discharge of mucus from the nose), galactorrhoea (excessive production of breast milk)

(Continued)