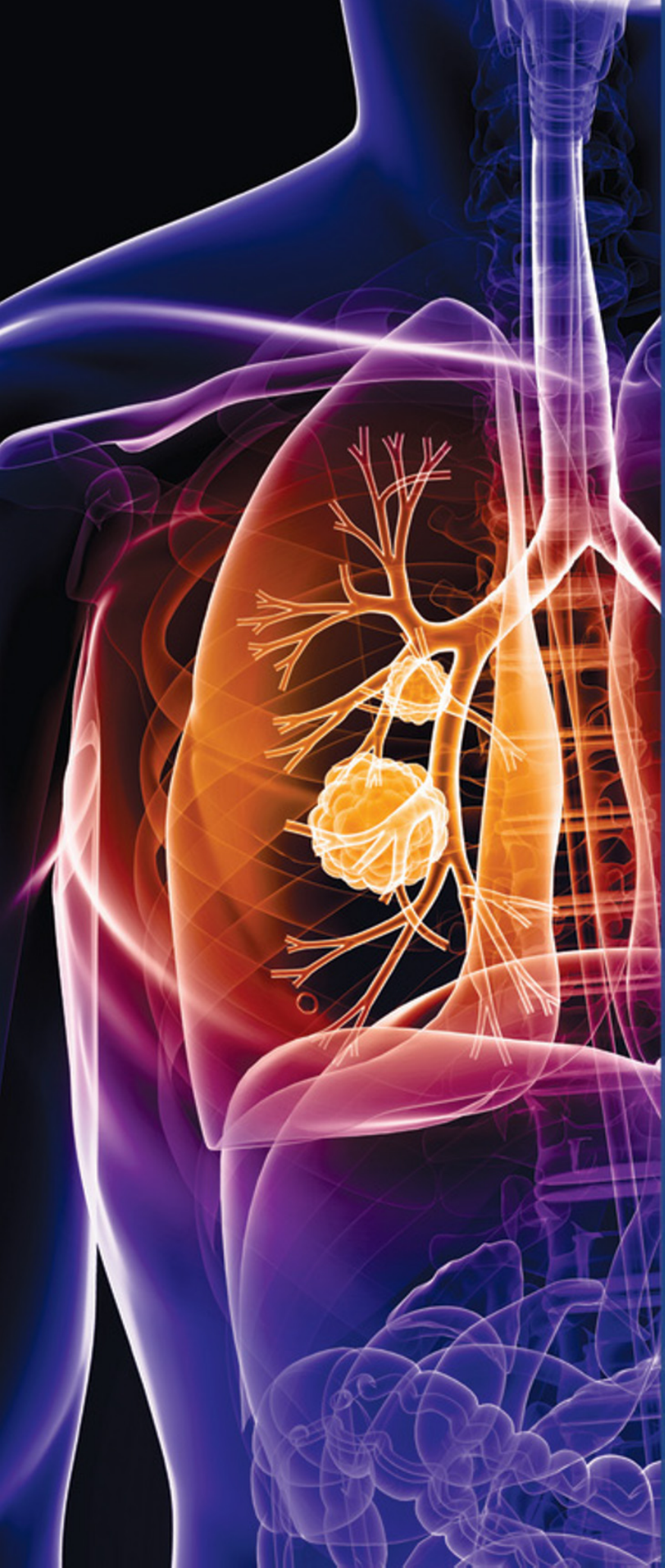

Pathophysiology for Nurses at a Glance

Muralitharan Nair
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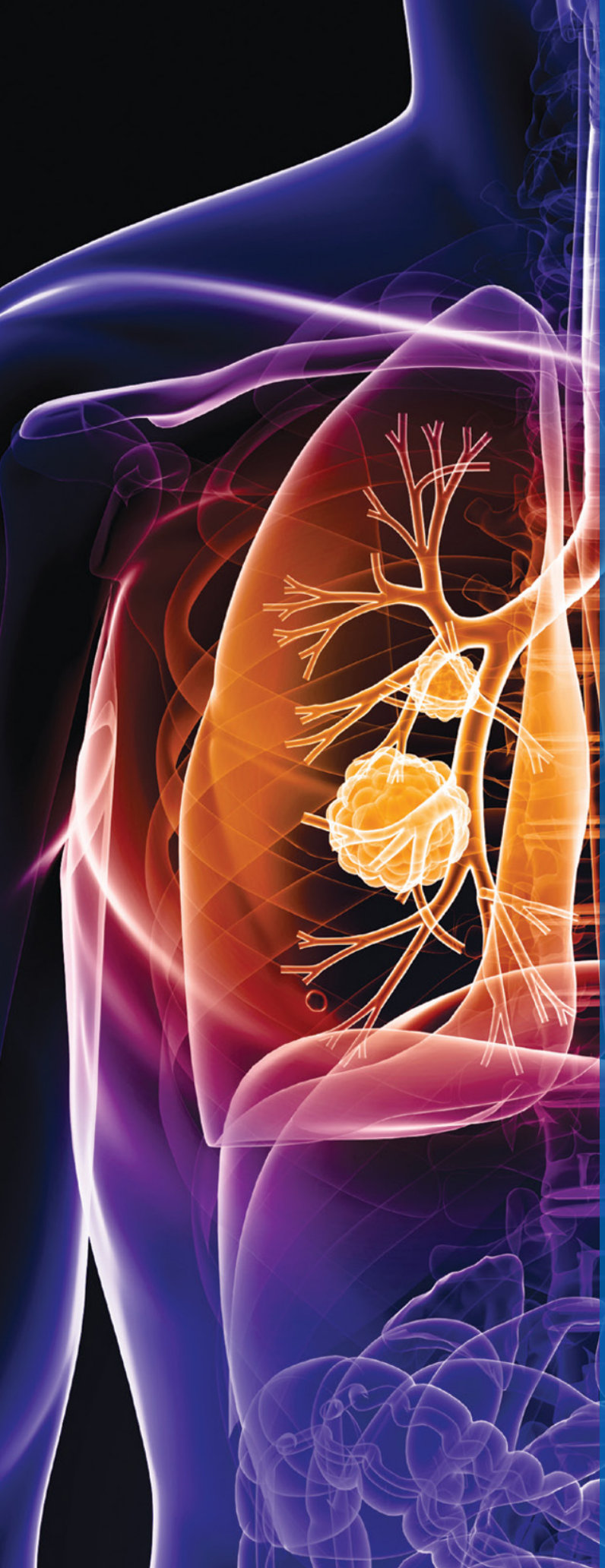

Pathophysiology for Nurses at a Glance

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WILEY Blackwell

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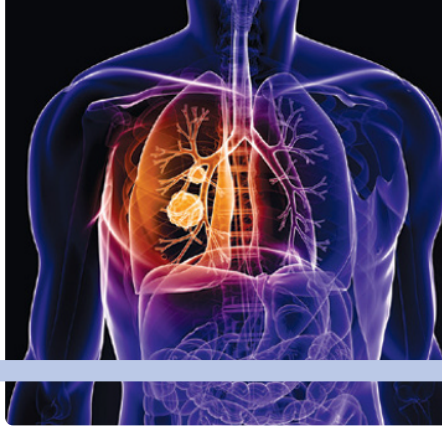
Contents



Preface viii
Abbreviations ix
Acknowledgements xi
How to use your revision guide xii
About the companion website xiii

Part 1 **Pathophysiology 1**
1 Key principles of pathophysiology 2
2 Cell injury, adaptation and death 4
3 Inflammation, tissue repair and regeneration 6
4 Cancer 8

Part 2 **Shock 11**
5 Cardiogenic shock 12
6 Anaphylactic shock 14
7 Hypovolaemic shock 16
8 Septicaemia 18

Part 3 **Immunity 21**
9 Human immunodeficiency virus 22
10 Non-Hodgkin lymphoma 24
11 Infectious mononucleosis 26

Part 4 **The nervous system 29**
12 Meningitis 30
13 Multiple sclerosis 32
14 Parkinson's disease 34
15 Cerebrovascular accident 36

Part 5 **The blood 39**
16 Anaemia 40
17 Deep vein thrombosis 42
18 Leukaemia 44
19 Thrombocytopenia 46

Part 6 **The cardiovascular system 49**
20 Heart failure 50
21 Myocardial infarction 52
22 Peripheral vascular disease 54
23 Angina 56

Part 7 The respiratory system 59
24 Asthma 60
25 Chronic bronchitis 62
26 Pulmonary embolism 64
27 Chronic obstructive pulmonary disease 66

Part 8 The gastrointestinal system 69
28 Peritonitis 70
29 Crohn's disease 72
30 Peptic ulcer 74
31 Ulcerative colitis 76
32 Bowel cancer 78

Part 9 The hepato-biliary system 81
33 Hepatitis 82
34 Cholecystitis 84
35 Pancreatitis 86
36 Liver cancer 88

Part 10 The urinary system 91
37 Renal failure 92
38 Pyelonephritis 94
39 Renal calculi 96
40 Bladder cancer 98

Part 11 The male reproductive system 101
41 Benign prostatic hyperplasia 102
42 Testicular torsion 104
43 Erectile dysfunction 106
44 Prostate cancer 108
45 Testicular cancer 110

Part 12 The female reproductive system 113
46 Cancer of the vulva 114
47 Menorrhagia 116
48 Breast cancer 118
49 Cervical cancer 120

Part 13 The endocrine system 123
50 Diabetes mellitus 124
51 Adrenal insufficiency 126
52 Cushing's syndrome 128
53 Hyperthyroidism 130

Part 14 The musculoskeletal system 133
54 Osteoarthritis 134
55 Osteoporosis 136
56 Osteomyelitis 138
57 Gout 140
58 Rheumatoid arthritis 142

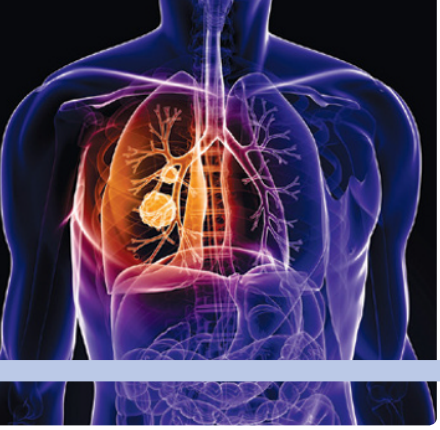
Part 15 **The skin 145**
59 Atopic dermatitis 146
60 Psoriasis 148
61 Acne vulgaris 150
62 Malignant melanoma 152

Part 16 **Ear, nose and throat 155**
63 Otitis media 156
64 Ménière's disease 158
65 Pharyngitis 160
66 Rhinosinusitis 162
67 Epistaxis 164

Part 17 **Vision 167**
68 Cataracts 168
69 Glaucoma 170
70 Age-related macular degeneration 172
71 Conjunctivitis 174

Appendices 176
Appendix 1 Cross-references to chapters in *Anatomy and Physiology for Nurses at a Glance* 176
Appendix 2 Normal values 178
Appendix 3 Prefixes and suffixes 180
Appendix 4 Glossary of terms 187

Further reading 189
Index 190



Preface

Pathophysiology for Nurses at a Glance provides you with a concise overview of a number health-related conditions. This text has been written with the intention of making the sometimes complex subject of pathophysiology understandable and stimulating. The human body has an astonishing capacity to respond to disease in a variety of physiological and psychological ways; it is able to compensate for the changes that occur caused by the disease process. This text considers those changes (the pathophysiological processes) and the effect they can have on a person.

Pathophysiology is concerned with the disturbance of normal mechanical, physical and biochemical functions. The word pathophysiology is a combined word from the Greek *pathos*, which means disease, and physiology is related to the numerous normal functions of the human body. Pathophysiology considers both the cellular and the organ changes that occur with disease, as well as the impact these changes have on body function. When something influences the normal physiological functioning of the body (such as disease), then this becomes a pathophysiological issue. It must be remembered, however, that normal health is not and cannot be exactly the same in any two people; as such, the term **normal** must be treated with caution.

To be able to care for people in a safe and effective manner, the nurse must have the knowledge and skills to meet needs inside and outside hospital and across health and social care, and meet the needs of an increasing older population and of those with long-term conditions.

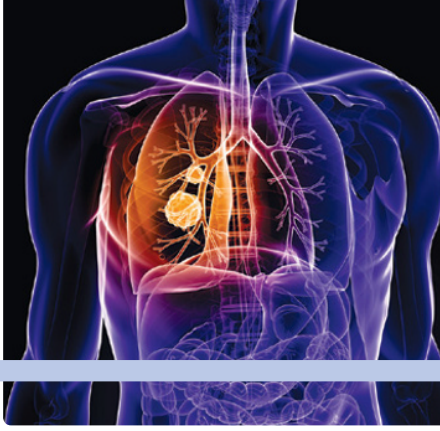
This text is mainly intended for nursing students who will come into contact with those who may have a variety of physically related healthcare problems such as pneumonia, diabetes mellitus and many more diseases. The focus of the text is on the adult person.

It is the intention of this text to develop knowledge and skills both in theory and practice and to apply this knowledge with the intention of providing safe and effective high-quality care. The overriding aim is to relate normal body function to pathological changes that may lead to disease processes, preventing the individual from leading a 'normal' life.

Using the fundamental approach found in this will text will provide readers with an essential understanding of applied pathophysiology.

Muralitharan Nair
Ian Peate

Abbreviations



ABG	arterial blood gas
ACE	angiotensin-converting enzyme
ADL	activities of daily living
ALL	acute lymphoblastic leukaemia
AKI	acute kidney injury
AML	acute myeloid leukaemia
AP resection	abdominoperineal resection
ATN	acute tubular injury
ATRA	all trans retinoic acid
AV	atrioventricular
BBB	blood-brain barrier
BECA 2	BReast CAncer gene 2
BMI	body mass index
BP	blood pressure
BPH	benign prostatic hypertrophy
BPM	beats per minute
BRCA 1	BReast CAncer gene 1
Ca	calcium
CB	chronic bronchitis
CBC	complete blood count
CBF	cerebral blood flow
CCF	Congestive cardiac (heart) failure
CCU	cardiac care unit
CHD	coronary heart disease
CKD	chronic kidney disease
Cl	chloride
CLL	chronic lymphoblastic leukaemia
cm	centimetre
CML	chronic myeloid leukaemia
CO	cardiac output
CO_2	carbon dioxide
COPD	chronic obstructive pulmonary disease
CSF	cerebrospinal fluid
CTPA	computed tomography pulmonary angiogram
CVA	cerebrovascular accident
CVD	cardiovascular disease
DNA	deoxyribonucleic acid
DVT	deep vein thrombosis
ECG	elecrocardiograph
ECM	extracellular matrix
ED	erectile dysfunction
ER	endoplasmic reticulum
ECSL	extracorporeal shockwave lithotripsy
ESWL	extracorporeal shock wave lithotripsy
FBC	full blood count
Fe	iron
FU	fluorouracil
GFR	glomerular filtration rate
GH	growth hormone
GI	gastrointestinal
GTN	glycerine trinitrate
Hb	haemoglobin
HBV	hepatitis B virus
HCC	hepatocellular cancer
HCL	hydrochloric acid
HCO3	bicarbonate
HCV	hepatitis C virus
HIV	human immunodeficiency virus
H Pylori	*Helicobacter pylori*
HUS	haemolytic-uremic syndrome
ICP	intracranial pressure
IDDM	insulin dependent diabetes mellitus
ITP	idiopathic thrombocytopenic purpura
IV	intravenous
IVC	inferior vena cava
K^+	potassium
LMWH	low molecular weight heparin
mg	milligramme
MI	myocardial infarction
mL	millilitre
MS	multiple sclerosis
MSU	midstream specimen of urine
MRI	magnetic resonance imaging
Na	sodium
NICE	National Institute for Health and Care Excellence
NIDDM	non-insulin dependent diabetes mellitus
NIV	non-invasive ventilation
NSAID	non-steroidal anti-inflammatory drug
O_2	oxygen
OA	osteoarthritis
PAD	peripheral arterial disease
PEFR	peak expiratory flow rate
PE	pulmonary embolism
PD	Parkinson's disease
pH	measures of the acidity or alkalinity of a solution
PPI	proton pump inhibitors

PVD peripheral vascular disease
SA sinoatrial
SOB short of breath
SVC superior vena cava
TIA transient ischaemic attack
TPN total parenteral nutrition
TTP thrombotic thrombocytopenic purpura
TURBT transurethral resection of bladder tumour
TURP transurethral resection of the prostate
UC ulcerative colitis
um micrometre
UTI urinary tract infection
VUR vesicoureteral reflux
WBC white blood cells

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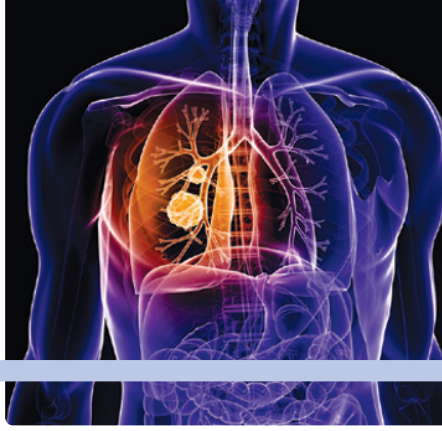

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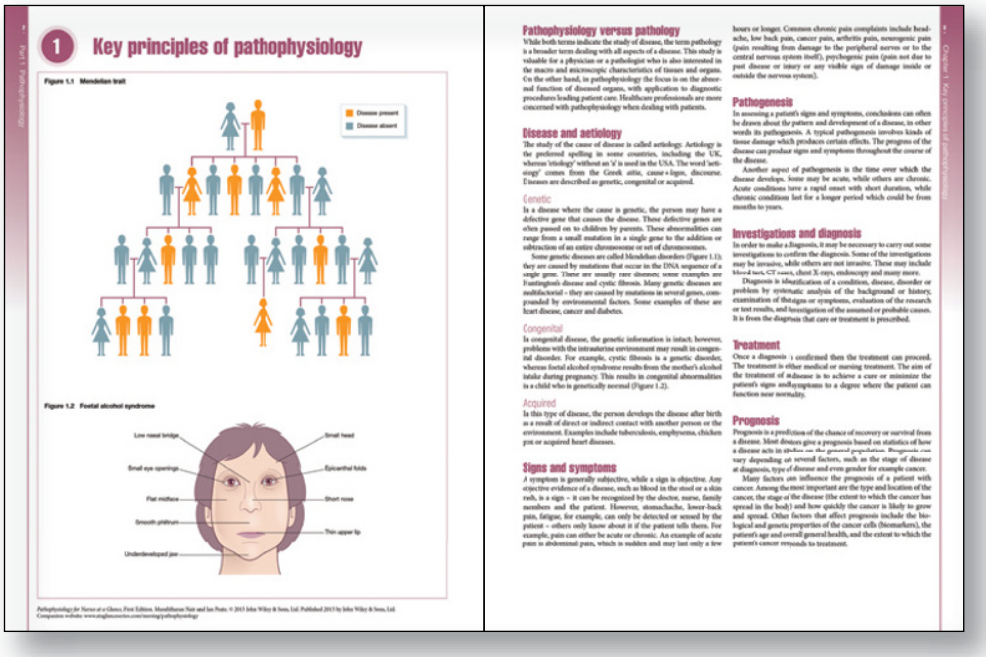

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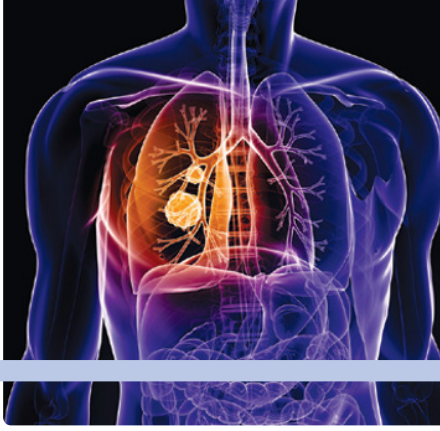

Don't forget to visit the companion website for this book:

www.ataglanceseries.com/nursing/pathophysiology

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

- Interactive multiple-choice questions
- Case studies to test your knowledge

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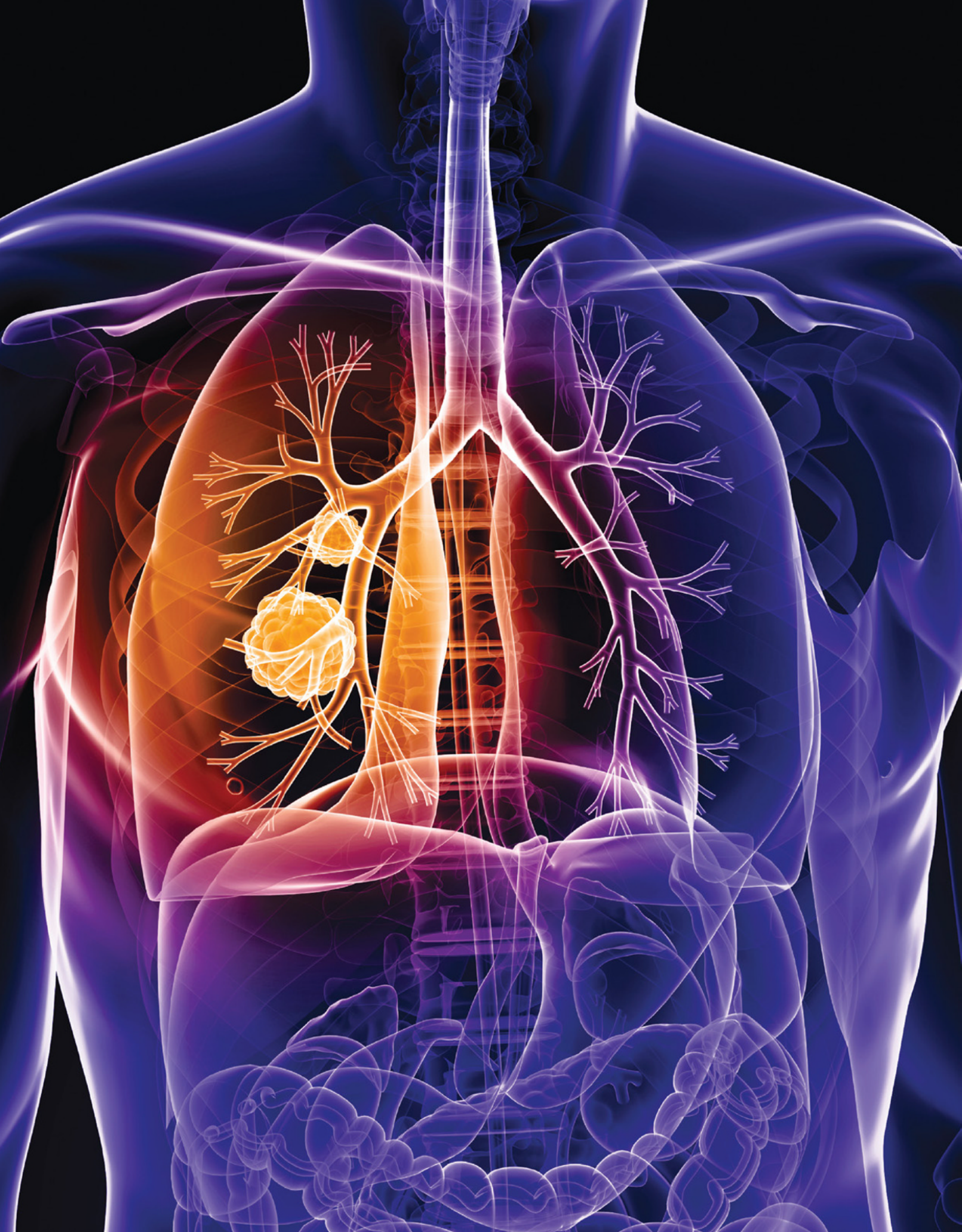


Pathophysiology

Part 1

Chapters

1 Key principles of pathophysiology 2
2 Cell injury, adaptation and death 4
3 Inflammation, tissue repair and regeneration 6
4 Cancer 8

1 Key principles of pathophysiology

Figure 1.1 Mendelian trait

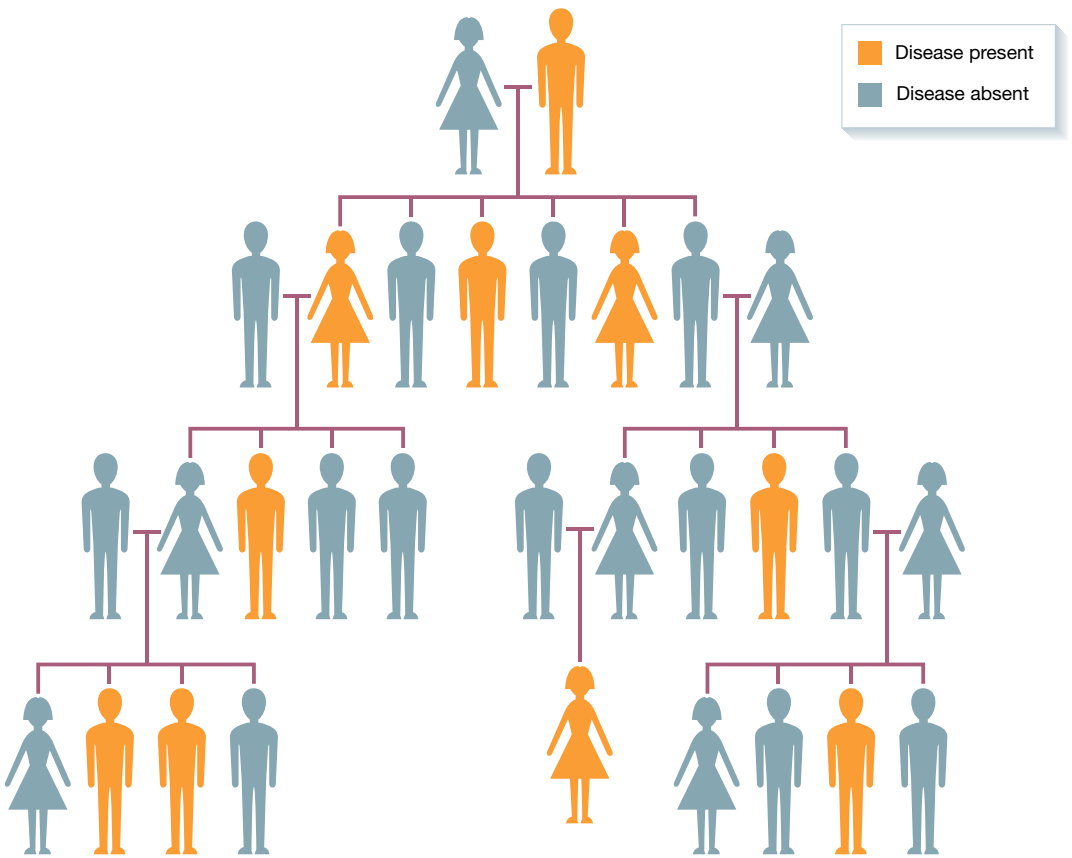
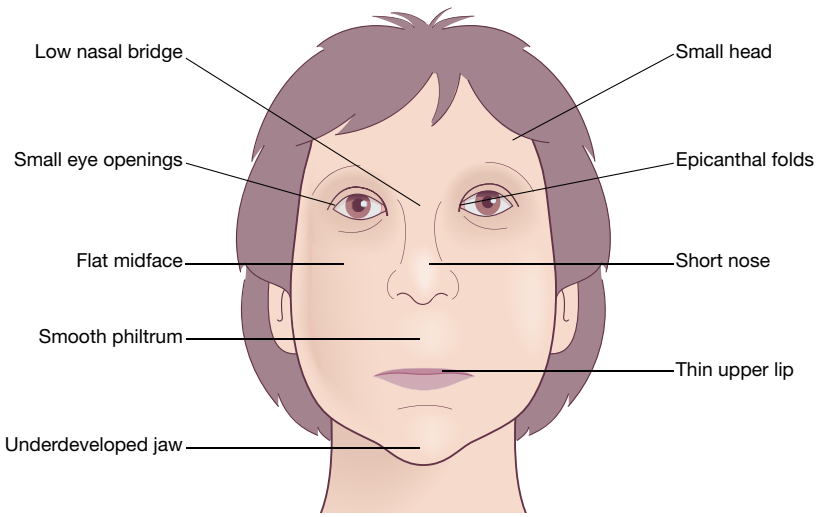


Figure 1.2 Foetal alcohol syndrome



Pathophysiology versus pathology

While both terms indicate the study of disease, the term pathology is a broader term dealing with all aspects of a disease. This study is valuable for a physician or a pathologist who is also interested in the macro and microscopic characteristics of tissues and organs. On the other hand, in pathophysiology the focus is on the abnormal function of diseased organs, with application to diagnostic procedures leading patient care. Healthcare professionals are more concerned with pathophysiology when dealing with patients.

Disease and aetiology

The study of the cause of disease is called aetiology. Aetiology is the preferred spelling in some countries, including the UK, whereas 'etiology' without an 'a' is used in the USA. The word 'aetiology' comes from the Greek *aitia*, cause + *logos*, discourse. Diseases are described as genetic, congenital or acquired.

Genetic

In a disease where the cause is genetic, the person may have a defective gene that causes the disease. These defective genes are often passed on to children by parents. These abnormalities can range from a small mutation in a single gene to the addition or subtraction of an entire chromosome or set of chromosomes.

Some genetic diseases are called Mendelian disorders (Figure 1.1); they are caused by mutations that occur in the DNA sequence of a single gene. These are usually rare diseases; some examples are Huntington's disease and cystic fibrosis. Many genetic diseases are multifactorial – they are caused by mutations in several genes, compounded by environmental factors. Some examples of these are heart disease, cancer and diabetes.

Congenital

In congenital disease, the genetic information is intact; however, problems with the intrauterine environment may result in congenital disorder. For example, cystic fibrosis is a genetic disorder, whereas foetal alcohol syndrome results from the mother's alcohol intake during pregnancy. This results in congenital abnormalities in a child who is genetically normal (Figure 1.2).

Acquired

In this type of disease, the person develops the disease after birth as a result of direct or indirect contact with another person or the environment. Examples include tuberculosis, emphysema, chicken pox or acquired heart diseases.

Signs and symptoms

A symptom is generally subjective, while a sign is objective. Any objective evidence of a disease, such as blood in the stool or a skin rash, is a sign – it can be recognized by the doctor, nurse, family members and the patient. However, stomachache, lower-back pain, fatigue, for example, can only be detected or sensed by the patient – others only know about it if the patient tells them. For example, pain can either be acute or chronic. An example of acute pain is abdominal pain, which is sudden and may last only a few hours or longer. Common chronic pain complaints include headache, low back pain, cancer pain, arthritis pain, neurogenic pain (pain resulting from damage to the peripheral nerves or to the central nervous system itself), psychogenic pain (pain not due to past disease or injury or any visible sign of damage inside or outside the nervous system).

Pathogenesis

In assessing a patient's signs and symptoms, conclusions can often be drawn about the pattern and development of a disease, in other words its pathogenesis. A typical pathogenesis involves kinds of tissue damage which produces certain effects. The progress of the disease can produce signs and symptoms throughout the course of the disease.

Another aspect of pathogenesis is the time over which the disease develops. Some may be acute, while others are chronic. Acute conditions have a rapid onset with short duration, while chronic conditions last for a longer period which could be from months to years.

Investigations and diagnosis

In order to make a diagnosis, it may be necessary to carry out some investigations to confirm the diagnosis. Some of the investigations may be invasive, while others are not invasive. These may include blood test, CT scans, chest X-rays, endoscopy and many more.

Diagnosis is identification of a condition, disease, disorder or problem by systematic analysis of the background or history, examination of the signs or symptoms, evaluation of the research or test results, and investigation of the assumed or probable causes. It is from the diagnosis that care or treatment is prescribed.

Treatment

Once a diagnosis is confirmed then the treatment can proceed. The treatment is either medical or nursing treatment. The aim of the treatment of a disease is to achieve a cure or minimize the patient's signs and symptoms to a degree where the patient can function near normality.

Prognosis

Prognosis is a prediction of the chance of recovery or survival from a disease. Most doctors give a prognosis based on statistics of how a disease acts in studies on the general population. Prognosis can vary depending on several factors, such as the stage of disease at diagnosis, type of disease and even gender for example cancer.

Many factors can influence the prognosis of a patient with cancer. Among the most important are the type and location of the cancer, the stage of the disease (the extent to which the cancer has spread in the body) and how quickly the cancer is likely to grow and spread. Other factors that affect prognosis include the biological and genetic properties of the cancer cells (biomarkers), the patient's age and overall general health, and the extent to which the patient's cancer responds to treatment.

2 Cell injury, adaptation and death

Figure 2.1 Causes of cell injury

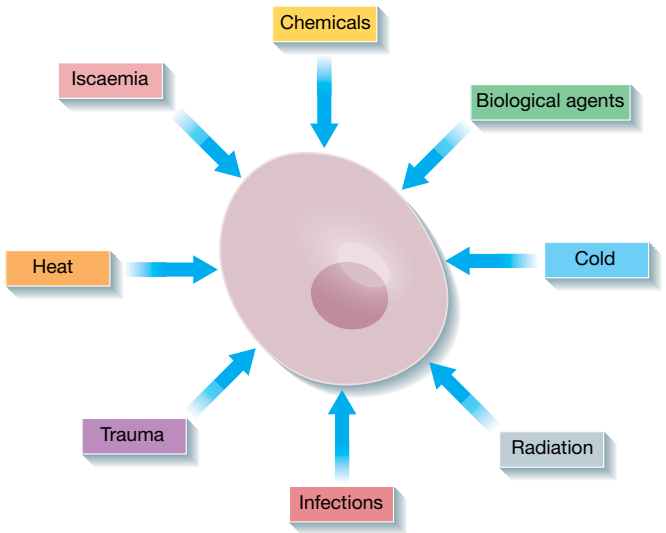


Figure 2.2 Cell atrophy

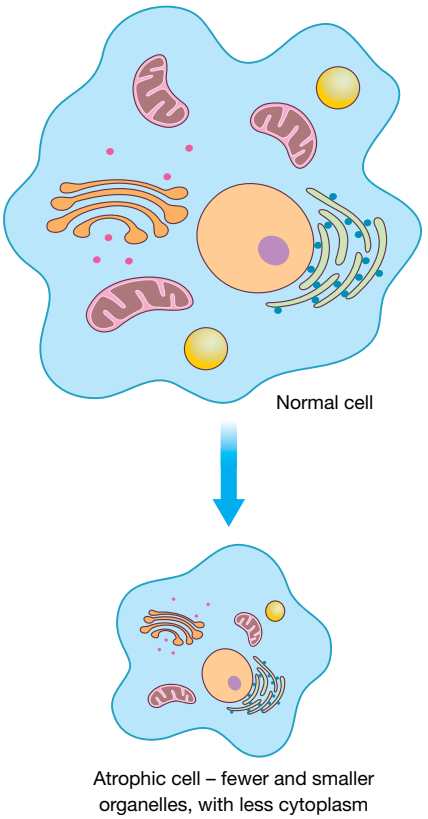
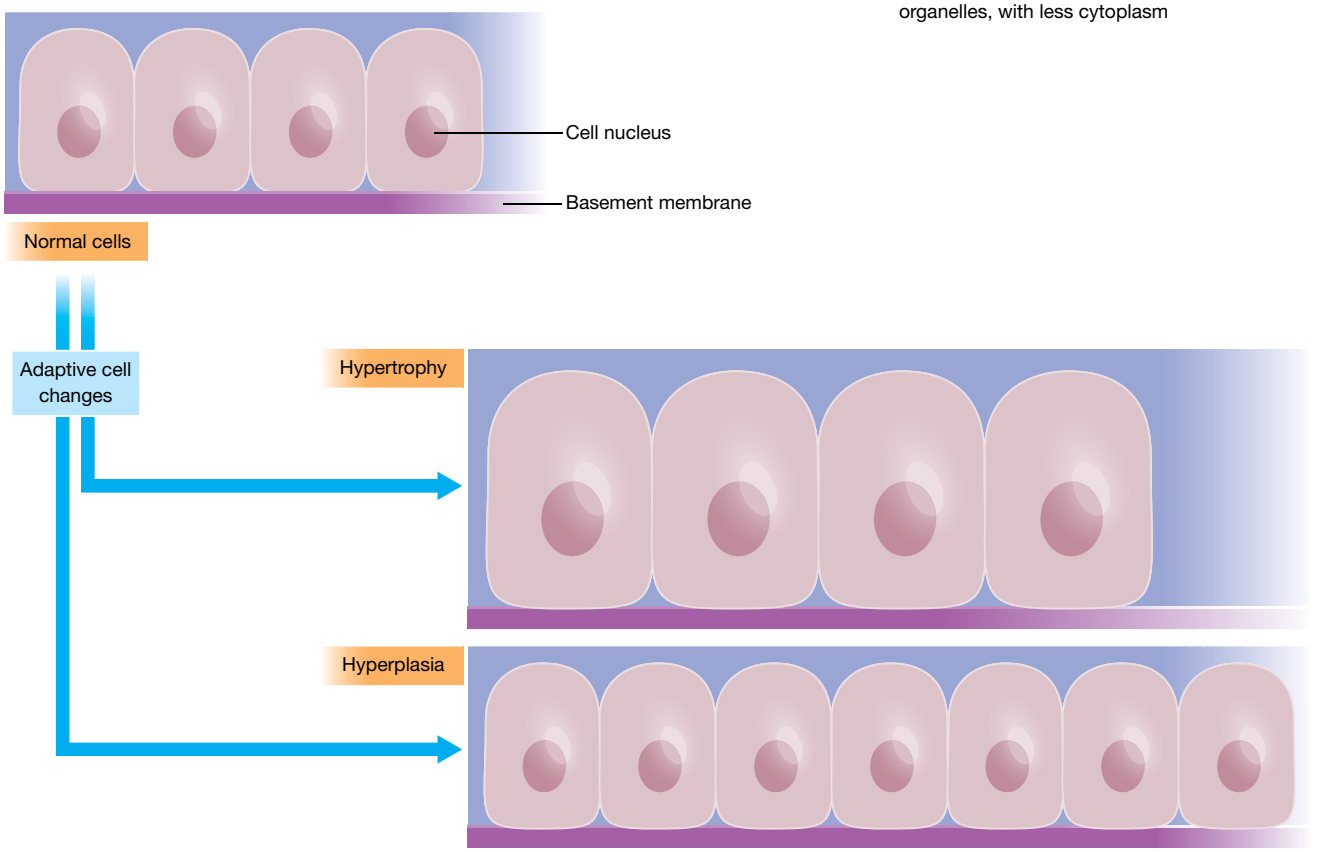


Figure 2.3 Hypertrophy and hyperplasia



Cell injury

The term 'cell injury' is used to indicate a state in which the capacity for physiological adaptation is exceeded by excessive stimuli, or when the cell is no longer capable to adapt without suffering some form of damage. Cell injury may be reversible or irreversible. Cell injury and cell death often result from exposure to toxic chemicals, infections and hypoxia (Figure 2.1).

Toxic chemicals

Chemical injury begins with the interaction between toxic chemicals and the plasma membrane. Many classes of toxic chemicals are capable of inducing acute cell injury followed by death. These include anoxia and ischaemia and their chemical analogues such as: potassium cyanide; chemical carcinogens, which form electrophiles that covalently bind to proteins in nucleic acids; oxidant chemicals, resulting in free radical formation and oxidant injury; activation of complement; and a variety of calcium ionophores. Cell death is also an important component of chemical carcinogenesis; many complete chemical carcinogens, at carcinogenic doses, produce acute necrosis and inflammation, followed by regeneration and preneoplasia.

Infections

Viruses induce cellular changes by two general mechanisms: (1) cytolytic and cytopathic viruses cause various degrees of cellular injury and cell death, (2) oncogenic viruses stimulate host cell to proliferate and may induce tumours.

Bacteria are relatively complex, single-celled creatures with a rigid wall and a thin, rubbery membrane surrounding the fluid inside the cell. They can reproduce on their own. Fossilized records show that bacteria have existed for about 3.5 billion years, and bacteria can survive in different environments, including extreme heat and cold, radioactive waste and the human body. Most bacteria are harmless, and some actually help by digesting food, destroying disease-causing microbes, fighting cancer cells and providing essential nutrients.

Hypoxia

Hypoxia is a deficiency of oxygen, which causes cell injury by reducing aerobic oxidative respiration. Hypoxia is an extremely important and common cause of cell injury and cell death. Causes of hypoxia include reduced blood flow, inadequate oxygenation of the blood due to cardiorespiratory failure and decreased oxygen-carrying capacity of the blood, as in anaemia or carbon monoxide poisoning (producing a stable carbon monoxyhaemoglobin that blocks oxygen carriage) or after severe blood loss. Depending on the severity of the hypoxic state, cells may adapt, undergo injury or die.

Adaptation

Cells adapt to the environment to escape and protect themselves from injury. Cellular adaptations are common and a central part of many disease states. The most significant adaptive states include atrophy, hypertrophy, hyperplasia and metaplasia.

Atrophy

Atrophy is a decrease or shrinkage in cell size caused by loss of subcellular organelles and substances (Figure 2.2). Atrophy can affect any , but it is most common in skeletal muscles, the heart, sex organs and the brain. However, physiological atrophy occurs in some glands. For example, the thymus gland undergoes physiological atrophy during childhood.

Hypertrophy

This is an increase in the size of the cells, thus enlarging the size of the organ (Figure 2.3). This can affect any cell but the cells of the heart, kidneys and skeletal muscles.

Hyperplasia

Hyperplasia is increased cell production in a normal tissue or organ (Figure 2.3). Hyperplasia may be a sign of abnormal or precancerous changes. This is called pathological hyperplasia. Hyperplasia may be harmless and occur on a particular tissue. An example of a normal hyperplastic response would be the growth and multiplication of milk-secreting glandular cells in the breast as a response to pregnancy, thus preparing for future breast-feeding.

Metaplasia

This is the reversible replacement of one differentiated cell type with another mature differentiated cell type. The change from one type of cell to another may generally be a part of normal maturation process or caused by some sort of abnormal stimulus. An example of metaplasia is the replacement of normal columnar ciliated epithelial cells of the bronchial lining by striated squamous epithelial cells.

Cells that die due to necrosis do not follow the apoptotic signal transduction pathway, but rather various receptors are activated that result in the loss of cell membrane integrity and an uncontrolled release of products of cell death into the intracellular space. This initiates an inflammatory response in the surrounding tissue. Nearby phagocytes are prevented from locating and engulfing the dead cells. The result is a build-up of dead tissue and cell debris at, or near, the site of the cell death.

Cell death

Cell death eventually leads to necrosis of the cell. It occurs when there is not enough blood flowing to the tissue, whether from injury, radiation, or chemicals. Necrosis is not reversible. One common type of necrosis is gangrene, which is often caused by damage from cold. There are many types of necrosis, as it can affect many areas of the body, including bone, skin, organs and other tissues.

Apoptosis

Apoptosis is derived from the Greek words *apo*, meaning away from, and *ptosis*, meaning to fall. The term 'falling away from' is derived from the fact that, during this type of prelethal change, the cells shrink and undergo marked blebbing at the periphery. The blebs then detach and float away. It is sometimes referred to as programmed cell death and, indeed, the process of apoptosis follows a controlled, predictable routine. However, it is normal for many cells to die of apoptosis as the nervous system forms; it is part of constructing appropriate connections. Apoptosis occurs in a variety of cell types following various types of toxic injury. It is especially prominent in lymphocytes, where it is the predominant mechanism for turnover of lymphocyte clones.

The resulting fragments produce the basophilic bodies seen within macrophages in lymph nodes. In other organs, apoptosis typically occurs in single cells, which are rapidly cleared away before and following death by phagocytosis of the fragments by adjacent parenchymal cells or by macrophages. Apoptosis occurring in single cells with subsequent phagocytosis typically does not result in inflammation. Prior to death, apoptotic cells show a very dense cytosol with normal or condensed mitochondria. The endoplasmic reticulum (ER) is normal or only slightly dilated.