

(a) Right lateral view

(b) Anterior view

Figure 1.3 Lateral and anterior views of the human body showing major cavities

Q What are the confines of (1) the thoracic cavity, (2) the abdominal cavity, and (3) the pelvic cavity?

the bony pelvis, sacrum and muscles of the pelvic floor. It contains the female reproductive structures, or some of the male reproductive structures (lower ureters, bladder and urethra). Other pelvic organs include the small intestine and the last part of the colon, the rectum and anal canal. It also includes the openings for the urethra, vagina and anus.

Blood vessels, lymphatic nodes and associated nerves are located in all the cavities. Sometimes it is necessary to be much more precise in locating organs of the body. A good example of this is the quadrants and the nine regions associated with the abdomen and pelvic areas (Figure 1.4). A surgeon requires such precision when a surgical incision has to be made.

Using appropriate terminology, describe the anatomical location of the organs of the thoracic and pelvic cavities of the body in relation to each other. Also, look up the prefixes associated with each major organ within the five major cavities of the body.

The basic needs of the human body

The basic needs of the living body identified by biologists as the characteristics of life are:

- 1 **Feeding or nutrition:** this encompasses the intake of raw materials to maintain life processes such as growth, repair and the maintenance of a normal environment inside the body.

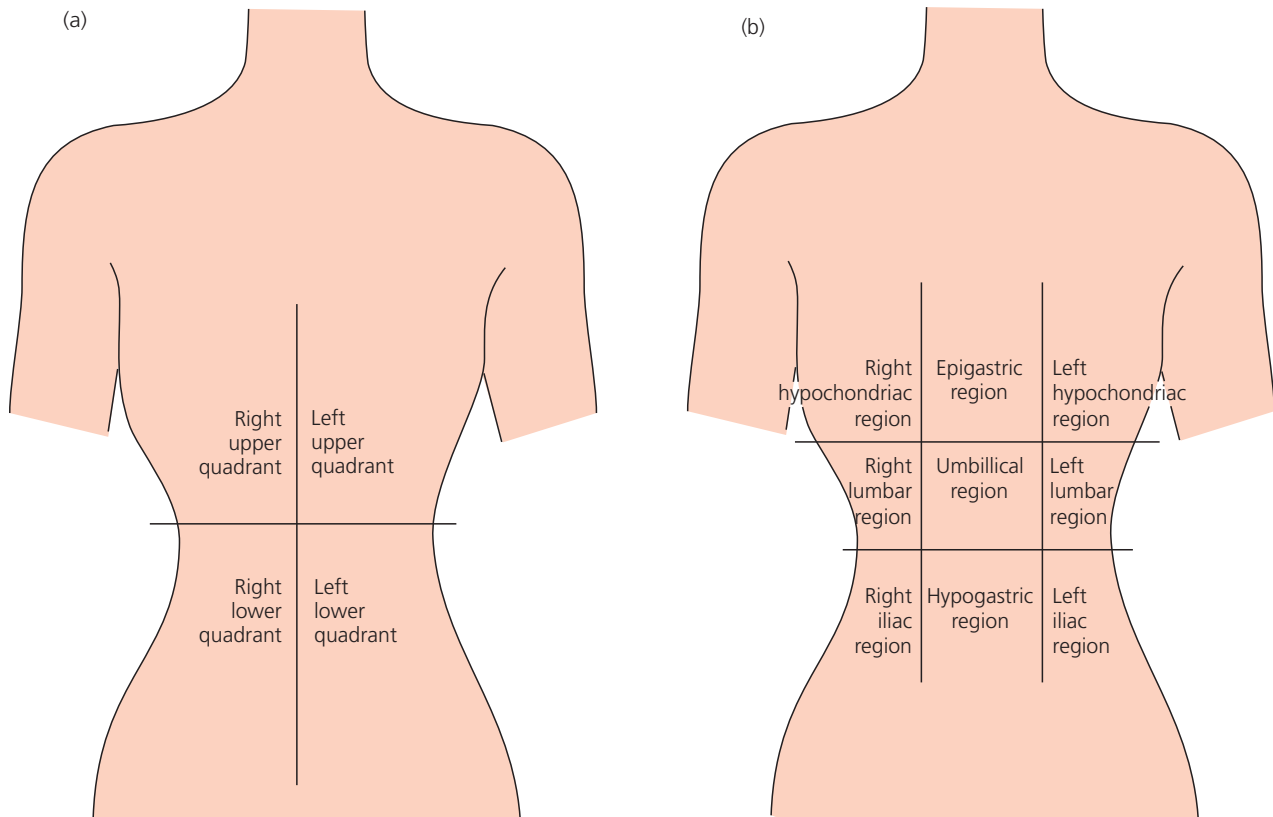


Figure 1.4 Anatomical subdivisions: (a) Quadrants of the abdomen; (b) The nine regions of the abdominal and pelvic regions.

Q Which quadrant confines the stomach?

Q Which region confines the appendix?

BOX 1.1 SURFACE ANATOMICAL LANDMARKS AND SOME MEDICAL TERMS

Surface anatomy is the study of external structures and their relation to deeper structures. For example, the breastbone (sternum) and parts of the ribs can be seen and felt (palpated) on the anterior aspects of the chest. These structures can be used as landmarks to identify regions of the heart and points on the chest at which certain heart sounds can be heard using a stethoscope (a process called auscultation). The normal 'lub-dup' sounds of the heart reflect normal structure and functioning of the heart valves. A deviation of this sound to the trained ear reflects abnormal structure and hence functioning.

Anatomical imaging involves the use of X-rays, ultrasound, computed tomography scans, and other technologies to create pictures of internal structures. Both surface anatomy and anatomical imaging provide important information in diagnosing disease. Healthcare professionals will become familiar with such techniques during their training.

The following terms are used to apply anatomy and physiology to some specialties in medical science (you may need to look up the suffix '-ology'):

- **Allergy:** diagnosis and treatment of allergic conditions

- **Cardiology:** the heart and its diseases
- **Endocrinology:** glands that release hormones and hormone disorders
- **Gastroenterology:** the stomach and intestines and their disorders
- **Gynaecology:** disorders of the female urinary tract and female reproductive organs
- **Haematology:** blood and blood disorders
- **Immunology:** mechanisms by which the body resists disease
- **Neurology:** the nervous system and its disorders
- **Obstetrics:** pregnancy and childbirth
- **Oncology:** cancer
- **Ophthalmology:** eye disorders
- **Otorhinolaryngology:** ear, nose and throat
- **Pathology:** diagnosis of disease based on changes in cells and tissues
- **Proctology:** disease of the colon, rectum and anus
- **Toxicology:** poisons
- **Urology:** disorders of the urinary tract and male reproductive organs

2 Movement: this is a characteristic in that people, or some parts of them, are capable of changing position.

3 Respiration: this refers to the processes concerned with the production of the energy (and related ideal body temperature and pH) necessary to maintain life processes and movement. In humans it involves breathing (external respiration)

and the breakdown of food (internal respiration) inside the cells of the body.

4 Excretion: this is the removal from the body of waste products of chemical reactions, and excesses of certain dietary substances (e.g. water).

5 Sensitivity and responsiveness: these are the processes

BOX 1.2 ACTIVITIES OF DAILY LIVING

To help nurses direct care to the basic needs of the body, Roper *et al.* in the 1980s devised a nursing model called the Activities of Daily Living (ADL) (Table 1.1).

Table 1.1 Activities of Daily Living (ADLs)

Breathing*
Eating and drinking*
Elimination*
Mobilizing*
Controlling body temperature
Maintaining a safe environment
Sleeping
Personal cleaning and dressing
Working and playing
Communication
Expressing sexuality*
Dying

*Based on basic needs of life. Others relate to further human needs. Table after Roper *et al.* (1990)

There is an underpinning assumption that the foundations of the earlier ADL models postulated by Roper *et al.* were adapted to the characteristics of life identified previously by biologists.

Human beings therefore are self-reproducing systems capable of growing and of maintaining their integrity by the expenditure of energy. They are, however, complex organisms, having cellular, tissue, organ and organ system levels of organization (Figure 1.5).

concerned with monitoring, detecting and responding to changes in the environment inside and outside the human body.

- 6 *Growth*: this generally implies an increase in size and complexity. It also includes repair of body parts which have undergone damage or need to be replaced.
- 7 *Reproduction*: this is necessary for the continuation of the species.

LEVELS OF ORGANIZATION

Cellular level

The human body is composed of trillions of microscopic cells. Each cell is regarded as a basic unit of life, since it is the smallest component capable of performing most, if not all, of the characteristics of life (or basic needs). Cells can digest food, generate energy, move, respond to stimuli, grow, excrete and reproduce. To support these activities, cells contain organelles that perform these specific functions (see Figure 2.3, p.24 and Table 2.1 p.25). To facilitate cell function throughout the body, the body contains many distinct kinds of cells, each specialized to perform specific functions. Examples include blood cells, muscle cells and bone cells. Each has a unique structure related to its function (see Figures 1.5 and 2.2, p.24). Receptors on the cell membrane or inside the cell inform genes of the desired function of the cell at any one moment in time. Genes are the controllers of all the cell's chemical reactions (collectively called metabolism), and these act indirectly

through their role in enzyme production. Enzymes are therefore of fundamental importance in the human body since they directly speed up chemical reactions so that they are compatible with a healthy life (Figure 1.6), but optimal enzyme action requires a microenvironment of ideal acidity and temperature. Genes are commonly referred to as the 'code of life' and enzymes as the 'key chemicals of life'. Adenosine triphosphate (abbreviated as ATP) is also another key chemical of life since this chemical is the cell's energy store, which is required to drive metabolic reactions at a rate that is harmonious with health (Figure 1.6). The chemical level of organization regarding cell structure and function is discussed in Chapter 5 under the umbrella term 'chemicals of life'.

Tissue level

A tissue is defined as a collection of similar cells and their component parts that perform specialized functions. There are many different types of tissues, so it follows that there must be different cell types that comprise these tissues. However, the entire body consists of just four primary tissues: epithelial or lining tissues, binding or connective tissues, muscular tissues, and nervous tissues (see Chapter 2, pp.52–8).

Organ and organ system levels

An organ is an orderly grouping of tissues that give it discrete function. Examples of organs are the heart, spleen, ovary and skin. Most organs contain all four primary tissues. In the stomach, for example, the inside epithelial lining performs functions of secretion of gastric juice and absorption of some chemicals such as alcohol. The wall of the stomach, however, also contains muscle tissue (for contraction of the stomach) to help with the breakdown of food, nervous tissue (for regulation), and connective tissue (to bind the other tissues together).

An organ system is a group of organs that act together to perform a specific body function, e.g. the respiratory system maintains the levels of oxygen and carbon dioxide in the blood. These systems work with each other in a coordinated way to maintain the functions of the body. The concepts of tubular (hollow) organs and compact (parenchymal) organs are introduced in Chapter 2, pp.58–9. The details associated with each organ are dealt with in their respective chapters, but the integration of organ function is important to note in this introductory chapter.

Each level of organization is instrumental in sustaining the functions of life for the human body. Table 1.2 illustrates each organ system's involvement in the regulation of the basic needs of the individual.

The basic needs are related to, and interdependent on, each other. For example, we must take in the raw materials of food and oxygen (both metabolites) in order to provide sufficient energy (ATP) to maintain normal body function (Figure 1.6). This energy is needed to support chemical reactions, such as those involved in growth and the muscle contraction necessary for movement. Consequently, these raw materials can be viewed as being the 'chemicals of life' (see Chapter 5).

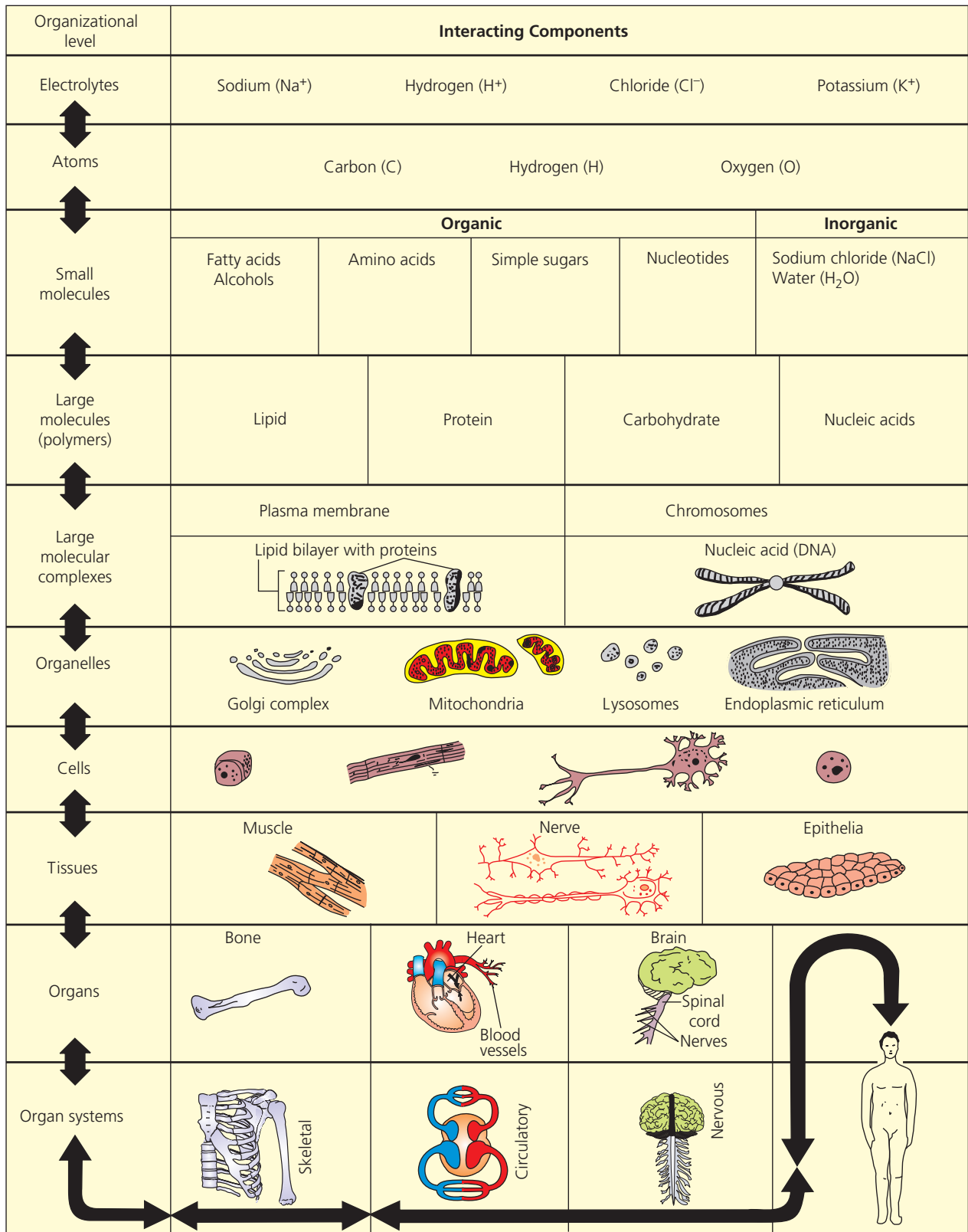


Figure 1.5 The hierarchy of organizational levels of the human organism indicates that specific interactions at each simpler level produce the more complex level above it.

Supply of raw materials for chemical reactions

Digestive
Respiratory
Circulatory
Skeletomuscular
Senses

} systems

Coordinated by neural–endocrine systems

Removal of 'wastes'

Circulatory
Excretory

} systems

Coordinated by neural–endocrine systems

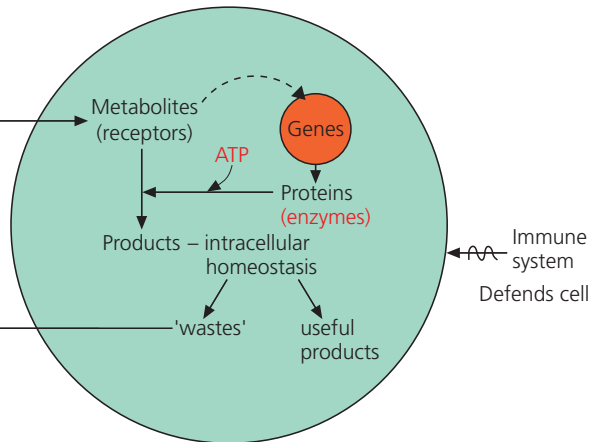


Figure 1.6 Involvement of organ systems in the regulation of intracellular homeostasis

Q Suggest why the following statements are used in physiology: (1) genes, ‘the code of life’; (2) enzymes, ‘the key chemicals of life’.

Table 1.2 Organ system involvement in maintaining the basic needs of the human body. The table demonstrates that all the organ systems are involved in maintaining the normal environment needed by the cells of the body, to enable them to perform the basic needs of the individual during health

Basic need	Organ systems involved
Intake of raw material	
Food	Digestive
Oxygen	Respiratory
Internal transportation	Circulatory, lymphatic
Excretion	Urinary, respiratory, the skin
Sensitivity and irritability	
Environment outside the body	Special senses, nervous, skeletomuscular
Environment inside the body	Nervous, endocrine
Defence	
Environment outside the body	Skin, special senses
Environment inside the body	Immune, digestive, endocrine
Movement within the environment	Skeletal, muscular, nervous, special senses
Reproduction	Reproductive, endocrine

Chemical reactions also produce waste products; these must be removed from the body to prevent cellular disturbances.

The interdependence of the basic needs means that a failure of one function leads to a deterioration of others (emphasizing further the ‘principle of complementary’). For example, malnutrition (‘mal-’ = bad or poor) results in the retardation of growth and development, lethargy, poor tissue maintenance, a reduced capacity to avoid infection, and a general failure to thrive.

Disorders arise at a cellular level, and, because of the interdependence of the components of the body, this means that a failure of one function leads to a deterioration of others. This is reflected in the diverse signs and symptoms of ill health that require clinical intervention to restore health (or homeostasis). For example, a patient who has had a heart condition may display signs and symptoms that reflect poor functioning of not only the heart, but also lungs and kidneys.

BOX 1.3 ILLNESS – A CELLULAR IMBALANCE

Since health is dependent upon optimal functioning of cellular components – receptors, genes, enzymes – and the cell’s microenvironment being ideally suitable for this optimal functioning, it follows that ultimately every illness originates from a functional disturbance arising from the cellular components (i.e. receptors and/or genes and/or enzymes) and/or the microenvironment at the cellular level. Arguably, cellular respiration is the most important chemical reaction in the human body, since its end products (ATP, heat and acidity) are essential in the provision of this ideal environment for optimal cellular metabolism (see Figure 2.11, p.36 and Box 2.1, p.22).

In the context of this introductory chapter, it seems logical to establish the basis for optimum (ideal) biological functioning. The main topic reviewed in the remainder of this chapter is homeostasis.

HOMEOSTASIS: THE LINK WITH HEALTH

An introduction to homeostatic control theory

The word ‘homeostasis’ literally translates as ‘same standing’, and is usually taken to indicate constancy or balance. Those students who have entered health care in recent years, having taken courses that have had a significant human biology component, are likely to have come across the term, since it is an important concept, especially in physiological studies.

The idea that a constancy of the internal environment of the human body is essential to life can be traced back to the views of the eminent French physiologist Claude Bernard, in the mid-nineteenth century. The turn of the twentieth century produced many important discoveries of how the body is regulated by hormonal and neural mechanisms.

In order to perform the basic functions of life successfully, there must be a ‘consistency’ within the body, and in particular in the environment inside cells, called the intracellular fluid (‘intra-’ = inside). The regulation of the composition and

volume of fluids that surround cells, which collectively are called the extracellular fluids, helps to keep this environment constant. The main components of these fluids are discussed in detail in Chapter 6. Briefly, they are:

- *Tissue fluid*: the fluid in which body cells are bathed. It acts as an intermediary between the cells and blood.
- *Plasma*: the cell-free component of blood. Together with blood cells, it circulates through the heart and blood vessels, supplying nutritive materials to cells and removing waste products from them.

Two processes by which the composition of these fluids is kept constant are:

- the intake of raw materials;
- the removal (excretion) of waste products of chemical reactions from the body, or the removal of excess chemicals that cannot be stored, destroyed or transferred to other substances inside the body.

Conventionally, homeostasis is therefore frequently considered to represent a balance or equilibrium between these two processes.

The modern view is that homeostasis is dependent upon an integration of physiological functions, since essentially all the organs of the body perform functions that help to maintain these constant conditions. The authors share the view that all the organ systems are homeostatic controllers that regulate the environment within cells throughout the body (Figure 1.6). This book concentrates on the homeostatic principles of human physiology, emphasizing in particular the role of each system in the maintenance of an optimal cellular environment (i.e. cellular homeostasis). It also discusses the influence of homeostatic control failure in producing some of the more common illnesses (i.e. homeostatic imbalances) that nurses, midwives and other healthcare practitioners are likely to encounter during their careers. In addition, the principles of healthcare intervention are mentioned in relation to the re-establishment of homeostasis and 'health' for the individual.

Principles of homeostasis

Cannon (1932), who introduced the term 'homeostasis', defined homeostasis as 'a condition, which may vary, but

remains relatively constant'. It was this definition, together with experience gained working alongside nurses and midwives using clinical laboratory values (Table 1.3), that inspired the authors to design the homeostatic graph (Figure 1.7). This is a simplified model to aid the understanding of a patient's physiological and biochemical parameters in health and disease.

Readers of this textbook are strongly recommended to familiarize themselves with this figure before dipping into other chapters, since variants of it are used throughout this book as a model to explain:

- homeostatic principles;
- how components of homeostasis (receptors, genes and enzymes) control cellular and hence body function;
- how the microenvironment (ATP, pH, temperature, composition) of the cell must be tightly controlled to optimize the production of the above homeostatic components and their functioning;
- how failure of the homeostatic components and/or changes to the microenvironment results in illness, and even death;
- an individualized approach to care, in which healthcare interventions are used to re-establish homeostasis for the patient, or to provide palliative care in symptom control to improve the quality of life for the dying patient.

The homeostatic range

The variations in parameter values provide a range within which the parameter can be considered to be regulated. Parameters within the body include: the concentration of chemicals within the body fluids (e.g. blood glucose), an expression of a function of an organ (e.g. heart rate), or the number of a particular cell type (e.g. red blood cell). The fluctuation in parameter values within their normal (or homeostatic) ranges provides the optimal condition in the body (Table 1.3 and Figure 1.7). The range reflects:

- *The precision by which a parameter is regulated*: some parameters, such as body temperature, have a very narrow range (adult values = 36.2–37.7°C), while others, for example blood volume, have a relatively larger range (male adult values = 52–83 mL/kg).

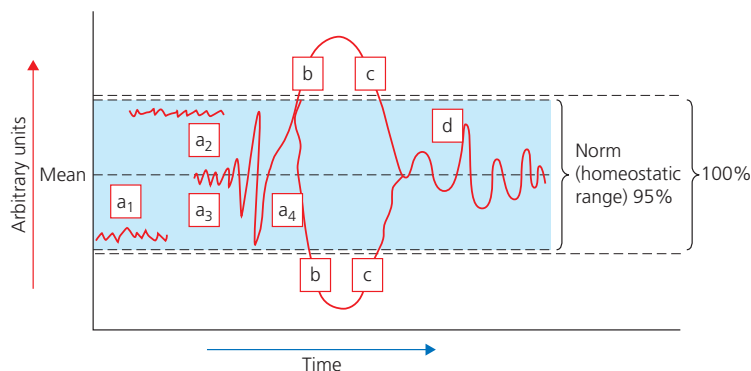


Figure 1.7 Principles of homeostatic control. (a₁₋₄) Homeostatic dynamism: values fluctuating within the homeostatic range, reflecting individual variation within the population (see text for details). (b) Homeostatic disturbance. (c) Homeostatic control mechanisms restore homeostasis. (d) Homeostasis re-established

Q Suggest how the homeostatic range accounts for every individual in the population.

Table 1.3 Normal laboratory blood values*

Clinical chemistry	Normal adult value (homeostatic range)
Sodium	136–148 mmol/L
Potassium	3.8–5.0 mmol/L
Bicarbonate	24–32 mmol/L
Urea	2.6–6.5 mmol/L
Creatinine	60–120 mmol/L
Glucose	Random, 3.0–9.4 mmol/L
CSF glucose	2.5–5.6 mmol/L
Total protein	62–82 g/L
Albumin	36–52 g/L
Globulin	20–37 g/L
Calcium	2.2–2.6 mmol/L
Transaminase	Up to 35 IU/L
pH	7.35–7.45
PCO ₂	4.7–6.0 kPa
PO ₂	11.3–14.0 kPa

CSF, cerebrospinal fluid; PCO₂, partial pressure of carbon dioxide; PO₂, partial pressure of oxygen.

*Note values are guides for judging health and disease. These ranges have proved to be clinically useful for judging health, disease and recovery in hospital wards and clinics

Q Describe in scientific terms what is meant by the term 'normal range' when equated with the values expressed in clinical laboratory tables.

ACTIVITY

Obtain from your clinical directorate a biochemistry ('U&Es') report and note the normal values.

- *Individual variation of values within the population:* one person's normal levels could fluctuate just above the minimum values of the range (Figure 1.7, a₁), while another person's optimal range could fluctuate close to the maximum values (Figure 1.7, a₂). It is also considered normal for some individuals to deviate on either side of the mean (or average) value (Figure 1.7, a₃). To account for all individual variations within the population, it is also possible for some individuals to 'bounce' between the minimum, mean and maximum values (Figure 1.7, a₄).
- *Variation of values within each person according to the changing metabolic demands:* it is quite usual for the maximum and minimum values of some parameters to vary within the individual as the person passes through the different developmental stages of the lifespan (Table 1.3 and Boxes 1.5 and 1.6). The dashed lines associated with the maximum, mean and minimum values in Figure 1.7 indicate the dynamic nature of these values (i.e. for some parameters the maximum value may increase). It is generally well known, for example, that blood pressure increases with the age of an individual, while most other parameter values decrease with adult age (e.g. muscle strength, visual acuity; see Chapter 19, pp.549–33).
- *Variation within each person occurring during times of illness:* (see the case studies in Section VI and the boxes in Chapters

BOX 1.4 PREGNANCY AS AN ALTERED STATE OF HEALTH

Midwives often refer to pregnancy as an 'altered state of health'. That is, variations of the homeostatic values of physiological parameters in pregnancy are considered quite normal and necessary for the development of the unborn baby. For example, the hormones oestrogen and progesterone surpass levels experienced in the non-pregnant state. This variation is necessary if implantation and placentation are to ensure structural and functional development of the unborn baby. The new homeostatic range has been adapted to meet the changing anatomical/physiological requirements associated with the developmental stage, pregnancy.

1–18, 21 and 22). Variations also need to account for the changes associated with the individual's sleep–wake activities (circadian patterns, 'circa-' = about, '-dies' = day; see Section VI).

The maintenance of a constant arterial blood pressure is frequently cited in textbooks as an illustration of a homeostatic process at work. However, it is important that this pressure is increased naturally during exercise as it increases blood flow through the exercising muscle, ensuring that the oxygen supply to the muscle supports the increased demand. The elevation of blood pressure in exercise is itself a homeostatic adaptive process. It acts to provide the appropriate environment for the changing chemical needs of muscle, and this highlights the most important feature of homeostasis: physio-

BOX 1.5 CLINICAL NORMAL AND ABNORMAL VALUES

In scientific research the term 'normal' means conforming to the usual healthy pattern. The normal (homeostatic) range in statistical terms defines values of parameters expected for 95% of the healthy population (e.g. the normal range of blood pH is 7.35–7.45; Table 1.3). Statistically, this means that 95% of the population (i.e. 95 out of 100 people) has a pH that falls in this range. Thus, the homeostatic range of a parameter is useful in making judgement regarding the health status of an individual. It must, however, be emphasized that each person is unique, and statistically it is expected that 5% of the 'healthy or so-called normal' population (i.e. 5 out of 100 people) naturally fall outside the normal range. These values reflect minor deviations from the homeostatic range, and are considered to be 'normal and acceptable' in clinical practice, and so need no clinical adjustments.

Alternatively, values that reflect large and sudden or long-term deviations from the homeostatic range which cannot be corrected naturally by body mechanisms are termed homeostatic 'imbalance' (i.e. signs and symptoms and/or illness), in which healthcare intervention may be not only desirable but essential to sustain 'normality' for the patient (Box 1.6).

Homeostasis, then, is about the provision of an internal environment that is optimal for cell function at any moment in time, despite the level of activity of the individual. Health occurs when bodily function is able to provide the appropriate environment. This usually entails an integration of the functioning of physiological systems, and its outcome is observed as physical well-being and psychological equilibrium. In order for homeostasis to be maintained, the body must have a means of detecting disturbances (or deviations) to homeostasis; assessing the magnitude of the deviation; and promoting an appropriate response to redress homeostasis (a process known as feedback). Feedback processes also provide the means of assessing the effectiveness of the response.

BOX 1.6 HEALTHCARE PROFESSIONALS – EXTERNAL AGENTS OF HOMEOSTATIC CONTROL

Homeostasis represents the processes necessary for the maintenance of conditions under which cells, and hence the tissues, organ systems and the body, can function optimally. For example, even small changes in a cell's environment, such as fluctuations in temperature, pH, ATP provision or hydration can disrupt the functioning of receptors, genes and enzymes within a cell and may even kill it. The disruptions to homeostasis, if not carefully monitored and controlled by the healthcare professional, could, in the extreme, be lethal for the patient, or at least delay recovery. In summary, health care is aimed at redressing (where possible) homeostasis for the patient. Health promotion and health education in their role of disease prevention are directed at sustaining homeostasis for individuals within the population. Thus healthcare professionals perhaps could be considered as *external agents of homeostatic control* (see 'Health care within a homeostasis framework' p.20 and case studies in Section VI which take this approach).

logical processes provide an *optimal* environment for bodily function which varies from one moment in time to another. While this may involve a near-constancy of some aspects of the environment (e.g. brain temperature), other functions may require a controlled change. The authors share the view that an increase in the white blood cell count, as occurs in response to an infection, and the increase in certain hormones (e.g. adrenaline, noradrenaline, cortisol), as occurs in response to stress, are further examples of homeostatic adaptive process rather than homeostatic imbalances.

Receptors and control centres

The initial disturbance in a physiological parameter is detected by receptors, sometimes referred to as monitors or error detectors. The function of these receptors is to relay information about the deviation to homeostatic control centres (analysers or interpreters). These centres interpret the disturbance as being above or below the homeostatic range, and determine the magnitude of the deviation. As a result, they stimulate appropriate responses via effectors that bring about the correction of the disturbance in order to restore homeostasis. Once the parameter has been normalized, the response will cease (Figure 1.8a, b).

Homeostatic controls

Occasionally, only one homeostatic control mechanism is necessary to redress the balance. For example, when the disturbance of blood glucose concentration exceeds its homeostatic range (hyperglycaemia; 'hyper-' = over or above, 'glyc-' = glucose, '-aemia' = blood) the hormone insulin is released, which promotes glucose removal from blood. More frequently, a number of controls are involved. For example, blood pressure is controlled by a number of neural and hormonal mechanisms

ACTIVITY

Briefly identify the three homeostatic regulators of acidity in the blood.

(see Figure 12.27, p.346). Another example is when blood acidity exceeds its homeostatic range (a condition referred to as an acidosis), three controls act to reduce the acidity values within the normal range (Clancy and McVicar, 2007a):

- *Buffers*: these chemicals act to neutralize the excess acidity (see Equations 5–9 in Chapter 6, p.130–2).
- *Respiratory mechanisms*: if the buffers are insufficient in removing the acidosis, then the rate and depth of breathing will increase in order to excrete more carbon dioxide, (a potential source of acid in body fluids).
- *Urinary mechanisms*: if the increased rate and depth of breathing are insufficient to remove the acidosis, then the kidneys will produce a more acidic urine and so reduce the acidity of body fluids.

These corrective responses are time dependent; some respond quickly to the disturbance, but if they should fail to re-establish homeostasis this prompts other control mechanisms to correct the deviation. The body therefore has short-term, intermediate and long-term homeostatic control mechanisms. Each controlling mechanism, however, has a limit or capacity on how much they can reverse the disturbance (Figure 1.8c). In the above example, these are the buffers, respiratory and urinary mechanisms, respectively.

Homeostatic feedback mechanisms

Negative feedback

Most homeostatic control mechanisms operate on the principle of negative feedback (i.e. when a homeostatic disturbance occurs, then in-built and self-adjusting mechanisms come into effect, which reverse the deviation). The regulation of blood sugar demonstrates the principle of negative feedback control. An increase in blood glucose concentration above its homeostatic range sets into motion processes that reduce it. Conversely, a blood glucose concentration below its homeostatic range (hypoglycaemia) promotes processes that will increase it. In both situations, the result is that the level of blood sugar is kept relatively constant over periods of time.

Positive feedback

Positive feedback occurs when the disturbance to a parameter results in an enhancement of this disturbance, that is, to promote a value above the homeostatic range rather than returning the value within the homeostatic range (via negative

ACTIVITY

Identify the homeostatic controllers and effectors of metabolism within cells.

ACTIVITY

Using the information in this chapter, you should be able to identify the in-built self-adjusting homeostatic mechanisms that are responsible for reversing elevated blood glucose concentration and acidity.

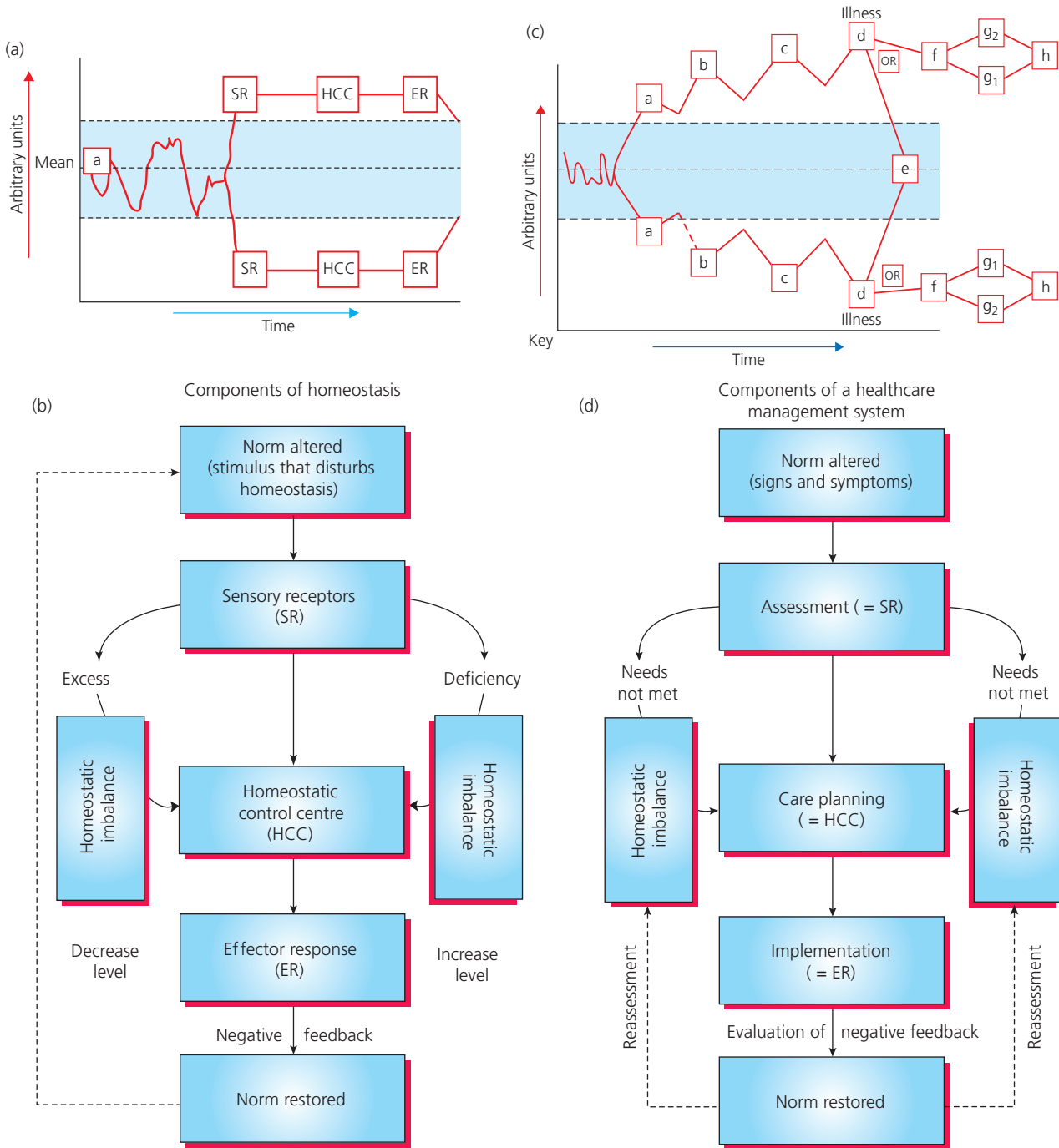


Figure 1.8 Homeostasis. Control, clinical intervention in illness and healthcare management systems. **(a,b)** General schemes demonstrating the roles of receptors, homeostatic control centres, and effectors via negative feedback in a control process. **(a)** Homeostatic dynamism reflecting individual variability. SR, Sensory receptors detect disturbance or deviations from the homeostatic range. HCC, Homeostatic control centres analyse the disturbance and its magnitude of change. ER, Effector response correcting the disturbance, usually by negative feedback. **(c)** Clinical intervention following homeostatic control system failure. a, Failure of receptors and/or short-term homeostatic control system and/or effectors in re-establishing homeostasis (note that there is some reversal of the homeostatic disturbance; however, the limit of these components has been exceeded and the disturbance is enhanced). b, Failure of receptors and/or intermediate homeostatic control system in re-establishing homeostasis (note these mechanisms initially reverse the disturbance; however, the capacity for the reversal is limited hence the disturbance is enhanced). c, Failure of receptors and/or long-term homeostatic control system and/or effectors in re-establishing homeostasis (note these mechanisms demonstrate some reversal of the homeostatic disturbance, but their capacity is exceeded; however, hence the disturbance is still present: i.e. illness arises). d, Healthcare intervention to re-establish patient homeostasis. e, Patient's re-established homeostatic status restored. f, Healthcare intervention is unsuccessful in re-establishing the patient homeostatic status. g₁, Palliative care improves quality of life via symptom control without re-establishing homeostasis. g₂, Health care cannot improve controls symptoms, and the disturbance is enhanced. h, Death occurs as a result of the inability to survive the homeostatic imbalance(s). [a, Represents boxes a₁–a₄ in Figure 1.7, p.11, reflecting the individual variability in the homeostatic range. The blue area represents the norm (homeostatic range) 95%]

Q Describe the function of the components of homeostatic control when there is a deviation in a parameter being monitored.

Q 'Healthcare professionals may be described as external agents of homeostatic control.' Discuss.

ACTIVITY

'Positive feedback is usually regarded as a homeostatic failure.' Discuss this statement.

feedback); positive feedback then results in a further increase, which causes a further increase, and so on. An example is observed during the menstrual cycle just before the release of the 'egg' (ovulation). The high levels of the hormone oestrogen at this part of the cycle reverse its normal inhibition regarding the secretion of luteinizing hormone (LH; release of this hormone is essential for ovulation to take place); the positive feedback now stimulates a surge of LH release, triggering ovulation. Since positive feedback induces change, the effects tend to be transient; most physiological systems utilize negative feedback mechanisms as a means of maintaining stability. An inability to promote change when necessary can, however, cause a change in health. For example, a failure to produce the surge of LH will result in sterility.

HOMEOSTASIS AND ILL HEALTH

If homeostasis and the functioning of homeostatic components provide a basis for health, then ill health will arise when there is a failure of the normal functioning of the components (Figure 1.8c, d). Imprecise functional mechanisms include:

- receptors fail to respond adequately to disturbances in the environment; and/or
- homeostatic control centres fail to analyse sensory receptor information, and/or analyse the information incorrectly, and/or send incorrect information to the effectors; and/or
- effectors fail to respond to corrective directions from the control centres.

All disorders are characterized by a primary disturbance of intracellular homeostasis within tissues somewhere in the body. The disease may be classed according to the primary disorder, such as a respiratory problem, a degenerative disorder, a

BOX 1.7 HOMEOSTATIC RANGE FLUCTUATIONS

The capacity to modify the homeostatic range is essential in certain circumstances (e.g. pregnancy, see Box 1.4) and is of benefit in other situations (e.g. exercise). Variations in homeostatic ranges and in positive feedback responses provide flexibility to homeostatic processes. As in positive-feedback responses, many of the changes promoted by set-point alteration relate to a specific situation and are short lived. Some resettings are permanent, however, and so promote long-term change. These responses are vital to the process of human development during the individual's lifespan. They allow for growth, functional maturation during fetal development and childhood, puberty changes during adolescence, and changes associated with becoming an adult. However, losing this regulation is associated with old age. Thus, because of the changing or dynamic nature of the parameters in health, the term 'homeostatic' (meaning 'same standing') may now be a little outdated, and in future years it maybe replaced by the more appropriate term 'homeodynamic' (meaning parameter variation). For the purpose of this text the homeostasis term is used.

tumour of a particular tissue, or as being caused by immune system dysfunction or infection. However, all will have consequences for extracellular homeostasis, hence the functioning of cells and tissues other than those involved in the primary disturbance. Thus, health care may be directed at symptoms apparently removed from the primary problem (e.g. relieving constipation in a patient with a breast tumour).

Homeostatic principles in clinical practice

The signs and symptoms of an illness will be related to the cellular homeostatic imbalances induced. For example, people with diabetes are classed as type 1 or insulin-dependent diabetes mellitus (IDDM) or as type 2 or non-insulin-dependent diabetes mellitus (NIDDM). Although not all people can be classified easily, as a general rule IDDM reflects a homeostatic failure of the pancreatic cells to produce the hormone insulin, and NIDDM reflects an imbalance in the target cells that respond to the insulin. The multiple organ system signs and symptoms of diabetes mellitus (see p.635), such as glucose in the urine (glucosuria) and vascular problems caused by fat deposits in the blood vessels (atherosclerosis), reflect a common failure in both types of diabetes in blood sugar management. They, therefore, are the result of a cellular imbalance, as are all illnesses. Furthermore, since cells only produce chemicals then it follows that all illnesses could be referred to as chemical imbalances (Box 1.8).

Clinical intervention in illness and disease is concerned with correcting underlying problems associated with homeostatic

BOX 1.8 GENERAL PRINCIPLES OF PHARMACOLOGY: ANTAGONISTIC AND AGONISTIC DRUGS

Since all illnesses are homeostatic imbalances of either an excess or deficiency of a product of cellular metabolism, drug companies have been successful in producing drugs that address the excess or deficiency.

Many are broadly classified as antagonistic and agonistic drugs. Generally, antagonistic drugs operate by decreasing the excess product. Conversely, agonists enhance the production of the product that is deficient. How do they do this? Drugs target the specific cellular homeostatic components that are at fault. For example, antagonistic drugs operate by blocking:

- the cellular receptor; and/or
- the gene; and/or
- the enzyme, which is responsible for producing the excess chemical.

Conversely, agonists operate by enhancing receptor activation, and/or the expression of the gene, and/or the enzyme action to increase the cellular product which is deficient.

The drug dosage required for correcting imbalance is dependent on the magnitude of the excess or deficiency (i.e. mild, moderate or severe imbalance) of the chemical products.

Other drugs target the endproducts of cell respiration, i.e. inhibitors or stimulants of ATP, which will slow or increase metabolism, respectively. Drugs may restore normal body temperature (e.g. antipyretics) and pH (e.g. antacids) so as to ensure the microenvironment is ideal for a 'healthy' metabolism via optimizing enzyme action (see Box 2.5, p.32).

The success of the human genomic and proteomics projects will only enhance the number of pharmacological products, which will be tailor-made to the individual's needs; they may also unravel the mysteries of how complementary and alternative therapies work at the cellular level.

imbalances (i.e. managing the symptoms) and enabling the patient to come to terms with the ‘disorder’. In other words, clinical practice is concerned with restoring, as effectively as possible, the homeostatic status of the patient at a cellular level (see Figure 1.8 and Box 1.6, p.13; Clancy and McVicar, 1996, 2007a). Using the above example, people with IDDM are treated with insulin injections, whereas diet (and perhaps hypoglycaemic drugs, such as gliclazide, glipizide and metformin) may be sufficient to control the problem in people with NIDDM, since the levels of insulin may be comparable to those of people without diabetes. By promoting normality, healthcare professionals are therefore acting as extrinsic homeostatic mechanisms. Some illnesses, however, such as terminal cancers, are not responsive to therapeutic intervention and, consequently, the imbalance results in long-term malfunction and eventually death. The healthcare professional in these circumstances provides palliative care to improve symptom management and hence the patient’s quality of life (Figure 1.8, labels c,f,g and Box 1.6, p.13). There are times, of course, when the healthcare practitioner can do nothing to prevent the death of a patient; for example, patients who suffer a massive blood loss either through trauma following a road traffic accident, or during a major operation, may die from hypovolaemic shock.

Homeostasis is usually considered to pertain to physiological or biochemical processes, and for the bulk of this text we will apply these principles. We also intend to introduce (in this chapter and expand on in later chapters in relation to human development, stress, pain and circadian rhythms), homeostasis pertaining to psychophysiological consistency within the body. Not separating the mind (‘psychological’) from bodily (‘physiological’) functions is important because the cells making up the human brain are no different in their basic characteristics from any other cells in the body. Thinking, emotions, behaviour and memories are all subject to the same physical and chemical laws of other functions of the body, and so to understand health fully it is necessary to be familiar with the psychophysiological processes that account for individual differences, as well as with the principles of homeostasis. In summary, individual differences are determined by a person’s genes (i.e. nature), which are modified by environmental (i.e. nurture) factors. The person and his/her environment are therefore inseparable. Thus, it is necessary that the nature–nurture implications of a person’s health and ill health should be recognized since these interactions provide the foundations of health care. Thus, the authors encourage healthcare professionals to take a transactional (or interactionist) view regarding the patient’s condition.

NATURE–NURTURE: AN INDIVIDUALIZED APPROACH TO HEALTH AND HEALTH CARE

Recent approaches to health care:

- recognize that people are individuals. Providing health care that is based solely on common biological change is unlikely to be fully effective for all patients, partly because people

vary biologically, but also because psychological and sociological variations can be profound and so will have an impact on the therapies;

- place an increased emphasis on the psychosocial influences on human behaviour and health. The focus has moved towards understanding how the environment acts on the individual, and hence how this interaction can be manipulated. The biological disturbances produced by such interactions will also be important here.

These are principles embraced by holism. Human beings are complex, so it could be argued that considering aspects of biopsychosocial well-being is itself being divisive, but in practical terms providing effective care requires the healthcare professional to have the appropriate psychological, sociological and biological information necessary to make decisions. Clearly, all three disciplines will underpin the care given (Figure 1.9).

In trying to explain the biological aspects of health, this book will use a systematic format to identify how body systems are constructed and how they function. In doing so, it will identify how changes in one system can induce profound alterations in the functioning of others, and how psychosocial perspectives may also have an impact on biological functioning. This latter interactional approach to health (and health care) is expanded upon here as an introduction and in more detail in the Chapters 20–22, which consider biological functioning in a more holistic framework.

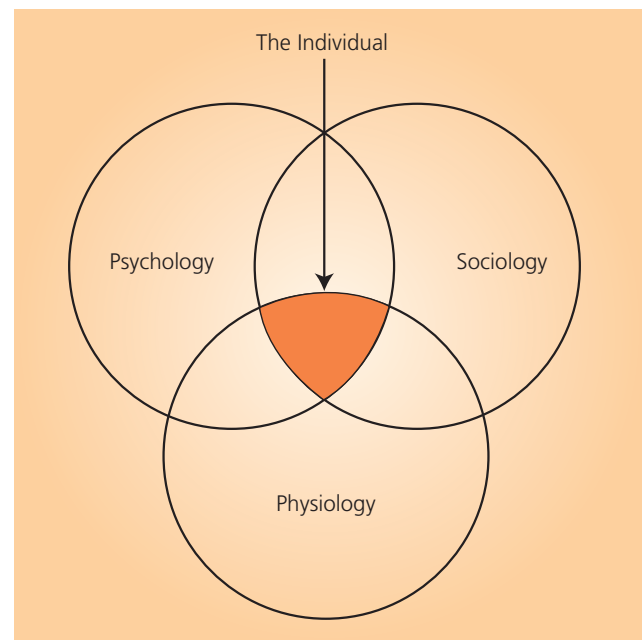


Figure 1.9 A simplistic model of holism

Q What does the term ‘holism’ mean to you?

BOX 1.9 SMOKING AS AN EXAMPLE OF AN INTERACTIONAL APPROACH TO HEALTH

Smoking frequently commences as a social or psychosocial pastime, but it is a habit that has been known for over 40 years to be associated with long-term health risks. Nicotine in tobacco smoke is a drug that acts as both a stimulant and a sedative. Its stimulant properties arise from the release of adrenaline and through the actions of nicotine on the central nervous system. They include:

- raising heart rate by 10–20 beats/minute;
- raising arterial blood pressure by 5–10 mmHg (0.7–1.3 kPa);
- raising the concentrations of blood glucose and free fatty acids;
- enhancing memory and alertness;
- improving cognition.

Its sedative properties also relate to its actions on the central nervous system:

- reducing stress perceptions;
- reducing aggressive responses to stressful situations;
- suppressing appetite.

Nicotine is also addictive. Smoking is a widespread behaviour, but it is considered to be the single most important, preventable health risk. Cigarette smoke contains over 2000 chemicals, and the risk to health is multisystemic. Smoking has been shown to substantially raise the risk of developing:

- cancer (lung, laryngeal, oral, oesophageal, bladder, kidney and pancreas): cigarette smoke contains more than 20 known carcinogens, collectively referred to as 'tar';

- chronic lung disease (chronic bronchitis, emphysema): this probably results from adaptive responses to the long-term presence of irritants from the smoke. Responses include increased numbers of goblet cells in the airways, increased mucus secretion (see Figure 2.26c, p.53), and loss of the hair-like processes called cilia that normally produce the 'mucus staircase' that removes mucus from the airways. The mucus provides a medium for bacterial growth;
- coronary heart disease (atherosclerosis): the causative factors are unknown, but there is suggestion that the main cause is the deposition of cholesterol in the walls of blood vessels of the heart (see Box 5.3, p.110 and Figures 12.7c,d, p.313 and 12.13, p.324). The presence of substantial amounts of carbon monoxide in cigarette smoke (and in the blood of frequent smokers) is also thought to have a role through its effect on the carriage of oxygen by blood;
- stroke, possibly linked to long-term cardiovascular adaptations (e.g. high blood pressure or hypertension), but may also be linked to cholesterol deposition in the walls of the blood vessels in the brain.

Smoking by pregnant women increases the risk of underweight babies and premature delivery. In such cases, the placental size is usually smaller than usual. Placental blood flow is likely to be reduced, hence poor fetal growth.

Changes in skin tone are also apparent in frequent smokers, often resulting in excessive facial wrinkling.

INTEGRATED APPROACHES TO HEALTH AND HEALTH CARE

Nature or nurture?

Discussions on the relative importance of biological (i.e. genetic or nature) and environmental (i.e. nurture) aspects have, for many years, provoked heated academic debates, especially in relation to human development. This is particularly the case when considering the factors that influence cognitive and behavioural changes, since both genetic and environmental contributions to psychological development are well recog-

nized. The discussion should also extend to physical factors, since lifestyle interactions undoubtedly induce homeostatic disturbance/imbalance (e.g. see Box 1.9 and Figure 1.10). The exact means by which the environment can influence psychological and physical functions are increasingly the subject of research, and there is now greater emphasis on prevention through health education.

The human genome was published in 2003. One surprise is that there seem to be just 30 000 or so genes in human cells. This is far fewer than the original estimates of 100 000 plus. Early estimates assumed a principle of one gene—one protein; as the number of genes is actually much lower, this suggests

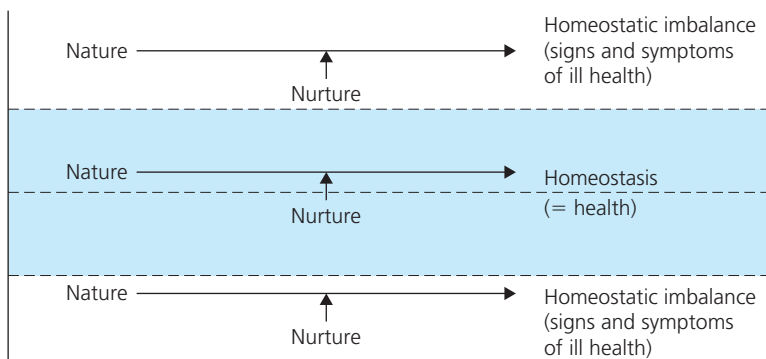


Figure 1.10 Homeostasis and homeostatic disturbance/imbalance/illness: a nature–nurture approach. Homeostasis, hence health, occurs through acquiring healthy nature–nurture interactions. Homeostatic imbalance(s), hence illness, occurs by inheriting the illness gene (nature), which is then exposed to environmental risk factors (nurture). [The blue area represents the norm (homeostatic range) 95%]

ACTIVITY

Various models of care have been developed during the last 40–50 years. Many of these take an ‘interactional’ stance, and the viewpoints expressed in this chapter are a development of those expressed in the Roy Adaptation Model. Interested readers are directed towards the work of Andrews and Roy (1991).

that there are as yet unrecognized ways by which the genetic blueprint is manipulated in cells to produce the diversity required in the human body. It has also stimulated further debate on the role of environmental interactions, particularly in such complex areas as human behaviour (see p.539 for further information regarding the Human Genome Project).

From the healthcare point of view, it is the interactions with the immediate environment that are of particular relevance, although the influences of the economic and political climates on that environment are also recognized as sources of illness. The application of this model, however, requires a definition of ‘environment’. If we take a broad definition, then an individual’s environment consists of the physical, chemical, social, emotional and spiritual circumstances in which the individual lives.

Interactions and psychological functions

Childhood and adolescence are viewed as being the main formative periods of our lives, as indicated by the complexity of psychophysiological development during these periods, although behaviour and personality remain labile throughout life.

Our mental faculties have a biological basis, since there are sites within the brain that have roles in, for example, emotion, aggression, sexual behaviour, cognitive functions and memory. The functioning of synapses (i.e. gaps between neurons) requires the activation of appropriate genes within brain neurons, not only for the existence of the neural components of the brain but also to promote neuronal growth and to enable a cell to produce the features necessary for neurochemical transmission at synapses. The observable characteristics produced by the activities of such genes in neural cells might be behavioural or cognitive, so there is a genetic basis to all aspects of psychological function. For example, ‘intelligence’ is currently considered to be primarily genetic, with 60–80% being accounted for by heredity. The remaining proportion identifies the importance of psychosocial interactions on brain development.

A genetic component helps to explain the apparent familial occurrence of some psychological disorders. By implication, gene mutation should be capable of inducing behavioural disturbance by altering neurological structure and functioning. Putative genes have been identified, but the situation is complicated by the likelihood that behavioural traits are characteristics that involve numerous genes, which increases the complexity of investigation.

Genetic involvement could also help to explain how behav-

our disorders are associated with specific neurochemical imbalances, such as an underactivity of neural pathways that utilize the neurotransmitters serotonin and noradrenaline in depressive behaviour (Box 1.10). Pharmacological therapies target this ‘nature’ component of behavioural disorders, and are an important tool.

Nevertheless, current pharmacological therapies might not reverse a disorder or may only provide a means of managing it. Psychotherapy is an alternative method that uses the lability of neural connections (referred to as ‘neuroplasticity’) in order to promote appropriate pathways and thus modify behaviour. How such ‘environmental’ interactions influence the expression of genes and behaviour has not been elucidated. It is clear, however, that to consider only the relative contributions of either genes or environment on psychological function is to take too narrow a perspective. Much of the brain function reflects an interaction of both, and this is reflected in clinical approaches to disorders of mental health (see Box 1.10, and the mental health case studies in Section VI).

BOX 1.10 DEPRESSION AS AN EXAMPLE OF AN INTERACTIONAL APPROACH TO HEALTH CARE

Psychological and sociological studies have made a considerable impact on the understanding of behaviour, yet the continued use of pharmacological therapies, whether as primary or secondary interventions, provides a reminder that the brain is a biological structure. The lack of psychological equilibrium in depression represents a disturbance of the internal environment of the brain, and the promotion of an optimal neural environment has failed. Clinical intervention aims to reverse the disturbance; this is illustrated by the therapeutic approaches used in the treatment of depression.

Depression is characterized in its extreme by a dysphoric mood, or a loss of interest or pleasure. The majority of studies indicate that the activities of monoamine neurotransmitters (noradrenaline and serotonin in particular) are reduced in depressive states, resulting in a functional imbalance between certain neural pathways of the brain. The aim of clinical intervention is to either artificially correct the neurochemical imbalance by using drugs or reverse the neurological change that resulted in the imbalance by using psychotherapy to re-establish neurological balance.

Pharmacological therapies largely involve the administration of drugs that either inhibit the uptake of neurotransmitter from the synapse, and so prolong its action (tricyclic antidepressants and serotonin-reuptake inhibitors), or maintain the presence of neurotransmitter for longer by preventing its breakdown by enzymes (monoamine oxidase inhibitors). The efficacy of these drugs in acute care is well established, but they do not remove the psychosocial cause of the disturbance. Drug companies still invest in producing drugs that activate or inactivate the components of the homeostatic theory (see Figure 1.8, p.14), in an attempt to provide a ‘quick fix’ to the patient’s problems.

Life events and a lack of social support have long been known to act as precipitating factors in the aetiology of depression. Cognitive behavioural therapy has been found to be as effective as pharmacological intervention for acute treatment, and may even be associated with lower rates of relapse.

Both treatments are therefore concerned with re-establishing neurological homeostasis, and an integrated approach should be taken that utilizes the best of each.

BOX 1.11 DYSPNOEA AS AN EXAMPLE OF AN INTERACTIONAL APPROACH TO HEALTH CARE

A balance between lung ventilation and lung perfusion is essential for health (see Box 14.22, p.413). Chronic cardiopulmonary disorders therefore frequently arise from heart disease, such as cardiomyopathies or myocardial infarction, or from lung diseases, such as chronic obstructive airway disease or pneumonia. These might be considered to be the primary problems. A common cause of heart disease is the presence of cholesterol-led atheromatous plaques within the coronary circulation, and that of lung disease is infection or environmental pollutants, such as cigarette smoke. In both cases, there are strong lifestyle or environmental links. Interactional influences on well-being can be framed within systems theory, by placing the individual in the context of component (internal) sub-systems, and wider, external supra-systems (see Figure 1.11). Important features of systems theory is the 'permeability' of boundaries between the various levels indicative of influencing factors between them, and the way in which the different levels are resistant to change in face of those factors – homeostasis could be considered an example of this. Acute pulmonary disorders are also possible, especially with regard to asthma or pneumonia. Once again, both usually have environmental risk factors.

Poor lung ventilation and/or perfusion causes dyspnoea (poor blood oxygenation and difficulties with breathing) and results in difficulty in maintaining the normal gas composition of arterial blood, and hence of the tissues elsewhere in the body. The management of dyspnoea includes some or all of the following:

- *Pharmacological methods*, including the administration of bronchodilators to improve ventilation, steroids to reduce inflammation, mucolytics to loosen mucus secretions, and anti-anxiety drugs to reduce the work of breathing and to reduce the risk of bronchospasm.
- *Physical techniques*, including:
 - positioning of the patient: a semi-prone position uses gravity to reduce pressure from the abdomen on the diaphragm, and hence on the lungs;
 - 'pursed-lip' breathing, to maintain alveolar expansion during breathing out, or 'diaphragmatic breathing' to reduce the work of breathing and to reduce air trapping as a consequence of airway compression during forced exhalation;
 - chest physiotherapy, to remove secretions (and suctioning to facilitate expectoration if necessary);
 - cough control, to facilitate removal of secretions.
- *Psychosocial therapies*, including relaxation and meditation to reduce anxiety and the work of breathing. Reduced anxiety will improve the disposition of the patient, and may also reduce the need for other interventions.
- *Oxygen therapy*, to facilitate oxygenation of alveolar gases; this is a clear example of environmental change that affects physiological parameters.

Thus, the aetiology of disorders that promote dyspnoea often has an environmental component, and the clinical interventions used to alleviate dyspnoea include both biological and environmental factors.

Interactions and physical functions

The success of health education programmes to reduce physical disorder also indicates that the environment (i.e. lifestyle) has an influence on genetic expression throughout the body. Some of these influences, such as diet, exercise and drug abuse, are well documented. Others are only poorly understood

(although the situation is changing rapidly), e.g. the extrinsic factors involved in the development of many cancers. Health education programmes are less apparent in such instances but scientists increasingly recognize causative or modulating agents, and so preventive approaches may eventually be available.

The interactional approach to health and health care in the context of physical functioning is illustrated in Box 1.11.

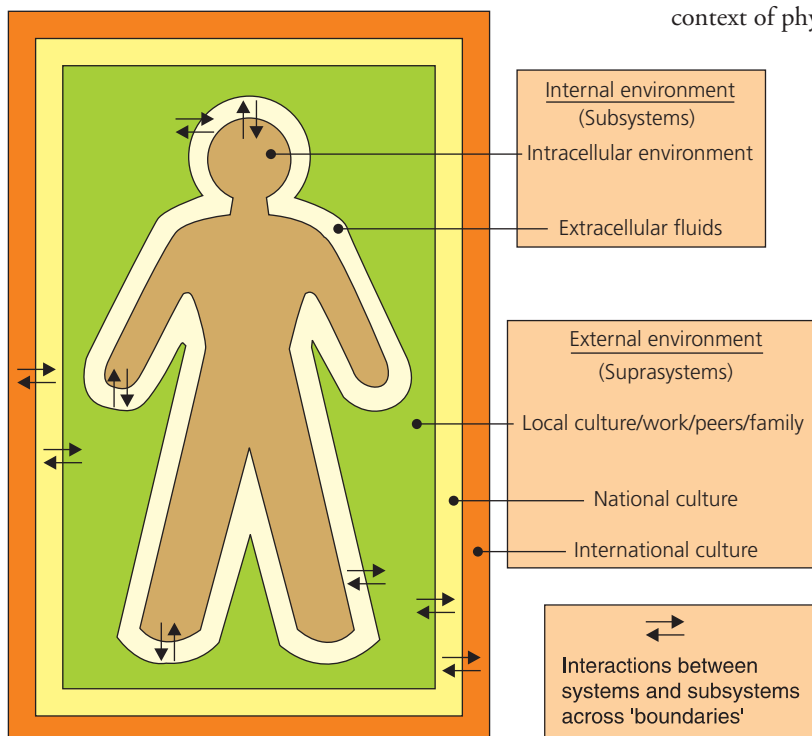


Figure 1.11 Systems theory and health. The individual represents a system with identifiable subsystems, which relate to intracellular and extracellular environments. The sociocultural environment, in which the individual lives, provides a number of suprasystems. Note the interactions across boundaries between the suprasystems and subsystems. These will influence the health of the individual

Q Which structures within the human body form our link to the environment?

BOX 1.12 HOMEOSTASIS AND THE HEALTHCARE PROCESS

Homeostatic principles are readily discerned within the stages of any healthcare process (compare Figure 1.8b and d, p.14).

- *Assessment and diagnosis.* The assessment of the health deficit and the biological, psychological, social and spiritual needs of the individual correspond to the detection and assessment of change by the receptors of the homeostatic control mechanism.
- *Planning.* The planning of health care, based on the assessment and diagnosis stage, is comparable to the ways by which homeostatic controls analyse and determine the responses needed to correct the disturbance. Furthermore, just as the body has specific homeostatic controls for different parameters, the healthcare practitioner needs to plan care according to the individual's needs. This can be illustrated using the simple example of dietary needs: a small amount of food, presented pleasantly, may be vital to encourage eating in the elderly patient who has a depressed appetite, whereas an energetic young patient will require a bulkier dietary intake, while a patient

with a learning disability may need reminding of what and when to eat.

- *Implementation.* In the healthcare process, implementation refers to putting into action the interventions planned in the previous stage. In a homeostatic perspective, this is analogous to the activation of effectors to produce the appropriate response.
- *Evaluation.* The effectiveness of care is assessed in this stage, much as feedback processes provide a means of evaluating a psychophysiological response. For example, has the injection been given to prevent the patient's pain?
- *Reassessment.* The cyclical nature of the healthcare process is emphasized by this stage, in which the patient is reassessed and new interventions considered if necessary. The dynamism of this process is also observed in homeostatic mechanisms described in this book; parameters fluctuate constantly within their normal ranges, and such changes must, therefore, be constantly reassessed.

HEALTH CARE WITHIN A HOMEOSTASIS FRAMEWORK

Interactions between the individual and the external environment act to change the internal environment of that individual, which is why intrinsic homeostatic processes are so important, since they prevent those changes from becoming destabilizing and causing biochemical change incompatible with well-being. In acting to prevent or reverse the effects of extrinsic influences on the internal environment, healthcare professionals are also demonstrating homeostasis in action (Box 1.12).

Homeostasis therefore provides a working framework for health and health care. Placing holism into a conceptual framework does not mean losing the sense of person, but presents us with the means of viewing the health–ill health continuum.

The impact of extrinsic factors on the internal environment of an individual may be influenced by the degree to which they act upon the individual, and the degree to which the individual is capable of responding to the imposed change. In other words, the impact of extrinsic factors on health will depend partly on the properties of the factors themselves, but also partly on the individual's innate capacity to respond to them. It is therefore also important to note that our ability to maintain psychophysiological equilibrium in the face of environmental stressors will be highly subjective because of genetic variation, the developmental stage of the individual, and individual sociocultural circumstances.

The interactional aspects of health, and the subjectivity that may be observed, are explored further in Chapters 20–22.

CONCLUSION

Homeostasis is a concept used throughout this book to explain how the internal environment is maintained at a level conducive to healthy functioning within the body compartments. Homeostatic control relies mainly upon negative feedback mechanisms that act to reverse disturbances and regulate parameters close to their optimal values. Prevention of parameter variation can be detrimental under some circumstances. The promotion of change via positive feedback mechanisms, or through resetting of homeostatic setpoints, is then of benefit. Failure of negative feedback processes, appropriate positive feedback responses, or setpoint resetting or a reduction in their efficiency, leads to homeostatic imbalance labelled illness.

Homeostasis based on nature–nurture interactions therefore provides a working framework for health and health care whereby the health carer perhaps could be considered as an external agent of homeostatic control. Healthcare processes involving assessment, diagnosis, planning, implementing care and reassessment of care are analogous with the natural components of homeostasis and as such are concerned largely with supplementing normal anatomical, biochemical and hence physiological processes in order to re-establish the homeostatic status (where possible) for the patient. It is with this framework that case studies in Section VI have been written. Chapter 2 emphasises that cells and their chemical products are the basic unit of health, illness and hence healthcare intervention. Most other chapters take a systemic approach to understanding the human body in health and illness emphasizing the homeostatic theme, while, finally, Chapters 19–22 focus more on the nature–nurture interaction in the understanding of human development, pain, stress and circadian rhythms.