INTRODUCTION

The body is always striving to maintain an internal equilibrium called homeostasis, which is regulated by three regions in the brain and maintained by a number of positive and negative feedback mechanisms. Disease or illness may develop when homeostasis is disrupted. The study of pathophysiology (or pathology) considers the changes that happen to normal anatomy and physiology due to illness and disease.

Any cellular change or damage can affect the whole body. Injury, malnutrition or invasion by pathogens can all disrupt homeostasis. Cells check for such imbalances during the cell cycle and replication and usually adapt successfully in response to such stresses. However, sometimes the cell cycle fails to detect unwanted changes and the resulting mutation may cause disease.

In the study of pathophysiology, we usually consider the causes of disease (aetiology), the changes to normal anatomy and physiology (pathophysiology), the signs and symptoms (clinical manifestations) of the disease or illness, along with diagnostic tests and treatments available.

This chapter examines changes to homeostasis and how this leads to illness or disease. To assess a patient’s symptoms and be able to plan, deliver and evaluate their care, nurses need to understand how changes to normal anatomy and physiology can lead to the development of illness and disease which can be minor or life-threatening, acute or chronic.

Useful resources

Nurses! Test Yourself in Anatomy and Physiology
Chapter 1
Ross and Wilson
Chapters 1, 3
QUESTIONS

TRUE OR FALSE?

1. The division of somatic cells involves four stages.

2. During their lifetime, cells face constant challenges to their normal function.

3. There are two types of homeostatic feedback mechanisms.

4. Dysplasia describes a reduction in cell size.

5. Disease can develop when normal homeostasis cannot be sustained.

6. When assessing pain, remember the acronym PQRST.

7. Cancer is a condition that develops when cells die uncontrollably.
MULTIPLE CHOICE

Identify one correct answer for each of the following.

8. Homeostasis can be defined as:
   a) functional changes caused by disease
   b) an unbalanced state, out of equilibrium
   c) a steady, dynamic state of equilibrium
   d) the exaggeration of an original response

9. Which of the following regions of the brain is not involved in maintaining homeostasis?
   a) pons
   b) medulla oblongata
   c) pituitary gland
   d) reticular formation

10. How many components are there in a homeostatic feedback mechanism?
    a) 6
    b) 5
    c) 4
    d) 3

11. Which cellular adaptation describes an increase in the number of cells in response to an increased workload?
    a) atrophy
    b) hypertrophy
    c) hyperplasia
    d) metaplasia
The majority of solid cancerous tumours arise from:

a) glandular tissue  
b) skin tissue  
c) nervous tissue  
d) epithelial tissue

The cellular transformation from a normal to a cancerous cell is called:

a) carcinogenesis  
b) replication  
c) mutation  
d) necrosis
**FILL IN THE BLANKS**

Fill in the blanks in each statement using the words in this box. *Not all of them are required, so choose carefully!*

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14 __________ describes the replacement of one adult cell with another.

15 The __________ of a disease can be intrinsic or extrinsic.

16 The development of a disease is called its __________.

17 Complete the stages in disease progression:

i) injury/exposure
ii) _____ phase
iii) prodromal period
iv) _____ phase
v) _________
vi) convalescence
vii) recovery
QUESTIONS

18. The pain radiating along the left arm often reported by MI patients is called __________ pain.

19. A solid tumour is usually classified according to the ______ from which it originates.

20. Cancer cells can __________ away from their origin.
The division of somatic cells involves four stages.  

Somatic cell division has two stages. The first stage is mitosis, when the nucleus and genetic material of the cell divide. In mitosis there are a number of different growth and synthesis phases. The second stage in cell reproduction is cytokinesis. At the beginning of this stage the cytoplasm divides, it ends when the new cell’s contents divides into two new daughter cells (by convention, new cells are called daughter cells). In gametes (sex cells), cell division and reproduction occur by meiosis.

During their lifetime, cells face constant challenges to their normal function.  

The normal functioning of the cell is constantly being challenged by stressors within the body and its external environment. The cell can normally adapt to such stressors and continue to function normally. However, sometimes the cell is unable to adapt to the challenges of stressors allowing a stressor to induce changes to the body’s state of health, causing disease or illness. When cells are stressed, they can undergo a number of changes: atrophy, hypertrophy, hyperplasia, metaplasia or dysplasia.

There are two types of homeostatic feedback mechanisms.  

The two types of feedback mechanisms are: positive feedback and negative feedback. Positive feedback occurs when a hormonal stimulus triggers an enhanced response so positive feedback exaggerates the original response. Negative feedback mechanisms restore homeostasis by detecting and correcting changes to the normal homeostatic conditions in the body. There are fewer examples of positive feedback than negative feedback, examples include the platelet formation in the blood coagulation cascade (haemostasis), or oxytocin release during labour contractions in childbirth. Examples of negative feedback include secretion of insulin from the pancreas to reduce high blood sugar levels back to normal, control of body temperature by thermoreceptors in the hypothalamus, control of blood pressure and respiration rate.

Dysplasia describes a reduction in cell size.  

Atrophy refers to a reduction in cell size. It can happen when cells are no longer used, malnourished, have insufficient blood supply, lack of innervation or have insufficient hormonal stimulation. Dysplasia describes abnormal growth or development of tissues or cells, leading to
a change in size, shape and appearance that is sometimes reversible but often precedes neoplastic (cancerous) changes.

5 **Disease can develop when normal homeostasis cannot be sustained.**

A disease will usually induce specific signs and symptoms that may need investigating. Disease develops, following disruption of the body’s normal homeostasis, while illness describes poor health caused by disease. Disease differs from illness because an individual may live a reasonably normal life and not be considered ill, despite having a disease. For example, an asthmatic person can live a normal life and not usually be considered ill because the body has adapted to the disease. However, the disease may make them more susceptible to certain illnesses such as respiratory infections or pneumonia.

6 **When assessing pain, remember the acronym PQRST.**

PQRST is a useful prompt to remember the questions to ask a patient when assessing pain.

P = precipitation/palliation – what causes the pain and what relieves it?
Q = quality – how could the pain be described, is it crushing, dull, sharp or stabbing?
R = region/radiation – where did the pain start and has it spread elsewhere?
S = severity – how bad is the pain, using a scale 0 = no pain to 10 = worst pain?
T = timing – when did the pain start and how long does it last?

7 **Cancer is a condition that develops when cells die uncontrollably.**

Cancer develops due to excessive and uncontrollable cell growth. A cancerous (or neoplastic) cell develops due to a mutation in a single cell which affects the control of normal function in the cell. The mutated cell is allowed to grow rather than being detected and destroyed as part of a cell cycle checkpoint. As the cancer cell matures, it fails to develop into the type of cell it should become therefore it is becomes impossible to distinguish the type of stem cell it originated from. The mutation allows the cell to grow and proliferate without the normal regulatory controls of cell growth and replication and it loses the ability to enter apoptosis (cell suicide). Initially the uncontrolled growth of the cancerous cells is localized but because they have lost the ability to perform apoptosis, the cells do not die and so the mass of proliferating cells begins to invade nearby tissue and may eventually metastasize to other areas of the body. Most cancers are solid tumours but malignancies can arise in the blood and these are called haematological cancers. Necrosis is an undesirable form of cell death usually caused by factors external to the cell, such as trauma, toxins or infection.
MULTIPLE CHOICE

8 Homeostasis can be defined as:

a) functional changes caused by disease  
b) an unbalanced state, out of equilibrium  
c) a steady, dynamic state of equilibrium  
d) the exaggeration of an original response

Homeostasis is an intricate and tightly controlled balancing act that the body uses to preserve the stability of the internal environment of cells, tissues, organs and systems and hence helps keep the body in good health. Homeostasis helps to maintain the volume and temperature of body fluids so that the body exists in a favourable environment to remain healthy. It is tightly controlled by three regions in the brain and is regulated by positive and negative feedback mechanisms. The hallmark of the ageing process is a decrease in the body’s ability to maintain homoeostasis because the body becomes less able to adapt to stressors. For example, many individuals suffer from hypertension as they get older because the body becomes less able to adapt to changes in blood pressure.

9 Which of the following regions of the brain is not involved in maintaining homeostasis?

a) pons  b) medulla oblongata  c) pituitary gland  
d) reticular formation

Three parts of the brain are involved in maintaining homeostasis in the body. They are the medulla oblongata in the brain stem, the pituitary gland and the reticular formation. The medulla oblongata controls a number of vital functions such as circulation and respiration. The pituitary gland controls the function of other glands and is involved in regulation growth, maturation and reproduction. The reticular formation is a group of nerve cells that control certain vital reflexes such as cardiovascular function and respiration. The pons is located just above the medulla oblongata but is not involved in maintaining homeostasis. It houses a number of cranial nerves that are involved in interpreting sensory information.

10 How many components are there in a homeostatic feedback mechanism?

a) 6  b) 5  c) 4  
d) 3

Every homeostatic feedback mechanism has three components: (1) a sensory mechanism – to detect deviations in the homeostatic equilibrium; (2) a control centre in the central nervous system – which regulates the body’s response to the change; and (3) an effector mechanism – which receives responses from CNS and that help restore homeostatic equilibrium.
Which cellular adaptation describes an increase in the number of cells in response to an increased workload?

a) atrophy  
b) hypertrophy  
c) hyperplasia  
d) metaplasia

Hyperplasia can also occur in response to hormonal stimulation or decrease in tissue mass. It differs from metaplasia, since metaplasia describes replacement of cells rather than an increase in cell number. Hypertrophy describes increase in cell size rather than increase in number of cells. Atrophy describes a destruction or shrinkage in cell size.

The majority of solid cancerous tumours arise from:

a) glandular tissue  
b) skin tissue  
c) nervous tissue  
d) epithelial tissue

Any cancer derived from epithelial tissue is usually classified as a carcinoma. Cancers derived from glandular tissue are called adenocarcinomas. Tumours of the nervous tissue are termed gliomas. Tumours derived from supporting tissue such as muscle, bone and connective tissues, are called sarcomas. Lymphatic and immune system tumours are classified as lymphomas. Tumours of the white blood cells are leukaemias, while tumours of the pigment cells are called melanomas. Plasma cell tumours are classified as myelomas.

The cellular transformation from a normal to a cancerous cell is called:

a) carcinogenesis  
b) replication  
c) mutation  
d) necrosis

There is no single cause that triggers carcinogenesis. It is likely to be induced by a number of triggers that interact together and that the cell is unable to defend against. These triggers can be genetic, lifestyle factors (smoking, diet, lack of exercise), hormonal, metabolic, viral, radiation, or chemical in nature. Carcinogenesis is a multi-stage process that involves a pre-clinical (latent) phase and a clinical phase. In some cancers, the latent phase can last for many years and in others it may be very short (weeks, months). The stages of carcinogenesis include:

I. initiation – the spontaneous genetic mutation;
II. promotion – confers a selective growth advantage that allows the abnormal cell to grow and proliferate;
III. progression – a series of additional mutations allow the mutated cell to continue to grow and evade apoptosis, by now the cells may not be recognizable from the parent cell;
IV. metastatic spread – the movement of cancerous cells away from their site of origin.
14 *Metaplasia* describes the replacement of one adult cell with another.

The replacement cell is usually better able to withstand stresses and endure changes. Metaplasia is a type of cell adaptation that most often occurs in response to irritation or chronic inflammation.

15 **The aetiology of a disease can be intrinsic or extrinsic.**

The aetiology (or cause) of a disease can be influenced by the individual’s biochemistry (intrinsic) or environmental (extrinsic) factors. Intrinsic biochemical factors are beyond an individual’s control since they include factors such as age, gender and genetics. Extrinsic factors are influenced by lifestyle and the external environment. They can include stress, diet, drug use (prescribed and narcotic), smoking, injury, bacteria or viral infections, exposure to chemical or radioactive agents, and exposure to extreme temperatures. Occasionally diseases arise that have no known aetiology, these are described as idiopathic.

16 **The development of a disease is called its pathogenesis.**

Most diseases have defined symptoms of progression that they will follow if left untreated. Some diseases are described as *self-limiting* because they resolve themselves without any interventions; other diseases will never resolve and are described as chronic. Patients with chronic diseases may experience periods of remission or exacerbation. During remission, symptoms improve or disappear while during exacerbation a patient may suffer increasing severity of symptoms. An example of a chronic condition that can undergo such periods is the inflammatory disease, rheumatoid arthritis.

17 **Complete the stages in disease progression:**

i) injury/exposure

ii) **latent** phase

iii) prodromal period

iv) **acute** phase

v) **remission**

vi) convalescence

vii) recovery

A disease progresses through a number of stages in the order described and is triggered by an injury or exposure to a pathogen. During the latent or incubation period, no signs or symptoms will be observed. During the prodromal periods, mild signs and symptoms will be observed but are usually non-specific (such as headache, nausea, fever). In the acute phase the disease is at its peak, complications may arise in this phase. If the patient is still able to function in a reasonably normal manner, this phase...
may be called a subclinical acute phase. Remission is a second latent phase that occurs after the disease has reached its peak. It can sometimes be followed by a relapse into another acute phase. During convalescence the disease has passed and the patient is progressing towards recovery. A patient is said to be recovered when there are no signs and symptoms of disease. At this stage the patient has generally returned to normal health.

The pain radiating along the left arm often reported by MI patients is called referred pain.

Referred (or reflective) pain describes pain experienced in part of the body at a distance from its area of origin. Referred pain is not completely understood but is thought to happen when nerve fibres from various regions or organs converge on the same levels of the spinal cord. The best-known example is pain experienced during a MI. Nerves from damaged cardiac tissue convey pain signals to spinal cord levels T1–T4 on the left side, which are the same levels that receive sensation from the left side of the chest and part of the left arm. This very close proximity of the converging nerve fibres confuses the brain, so it interprets the heart pain as coming from the chest area and left arm (and sometimes the neck or jaw). Figure 1.1 illustrates common areas where referred pain may be experienced.

Figure 1.1 Referred pain regions
A solid tumour is usually classified according to the tissue from which it originates.

The majority of solid tumours arise from epithelial tissue since epithelial tissue is the main type of tissue that lines the internal and external surfaces of the body’s organs (for example, the lungs, colon and breasts). Tumours arising from epithelial tissues are called carcinomas. Haematological cancers are classified according to the blood cells from which they originate.

Cancer cells can metastasize away from their origin.

The metastasis of cancer cells is the movement or spread of the cells to other areas of the body and may occur in three ways:

I. The growing mass of cells penetrates a blood or lymphatic vessel, enters the circulating blood or lymph and travels through either system. The cells can then settle in any organ or region of the body. Some types of cancer have sites they tend to metastasize to.

II. Cancerous cells can be spread during surgery.

III. They can spread to neighbouring organs – this is common in the GI tract because of the close proximity of organs.

There are many pathophysiological changes associated with the development of metastases. Sometimes it is only through the detection of such metastatic signs and symptoms that a cancer is diagnosed. Some common clinical signs of metastases include pleural effusion on the lungs which may indicate a metastasis in the lungs which is a common metastatic site for breast cancers (or it may be indicative of a primary lung tumour); ascites in the peritoneum can indicate metastasis in the peritoneal cavity which is a common metastatic site for ovarian cancers.
Inflammation, infection and immunity

INTRODUCTION

The immune system has three lines of defence: (1) physical and chemical barriers to infective agents; (2) the inflammatory response; and (3) the immune system reaction. When pathogens invade the body, there are two types of possible immune response that can occur: specific and non-specific.

Infection occurs when the body’s defence mechanisms break down or are overcome by pathogens. Inflammation is a protective attempt by the body to remove the inflammatory stimulus and initiate the healing process in the tissue. Inflammation can be classified as either acute or chronic. Acute inflammation is the initial response of the body to harmful stimuli while chronic (prolonged) inflammation causes a change in the type of cells which are present at the inflammation site. In the absence of inflammation, wounds and infections would never heal, causing progressive destruction of the tissue.

Immunodeficiency occurs when the immune system is less functional than normal, resulting in recurring and life-threatening infections. In contrast, autoimmune diseases are caused by a hyperactive immune system that attacks normal tissues as if they were foreign organisms. Hypersensitivity disorders are caused by an overactive immune response.

Nurses need to recognize the characteristics of infection and inflammation to treat such conditions quickly and efficiently as certain infections such as septicaemia can develop quickly and be life-threatening.

Useful resources

Nurses! Test Yourself in Anatomy and Physiology
Chapter 11

Ross and Wilson
Chapter 15
QUESTIONS

TRUE OR FALSE?

Are the following statements true or false?

1. For infection control, nurses should always wear gloves during patient contact.

2. Bacteria contain carbohydrates that may cause infection.

3. Fungi can be classified as yeasts or moulds.

4. Parasitic infections are very common in cold climates.

5. B-cells are responsible for humoral immunity.

6. Disorders of the immune system fall into three main categories.
MULTIPLE CHOICE

Identify one correct answer for each of the following.

7. Tonsillitis is most commonly caused by:
   a) a virus
   b) a bacteria
   c) a fungus
   d) a protozoa

8. Pathogens can be transmitted via which of the following routes?
   a) airborne
   b) arthropods
   c) direct and indirect contact
   d) all of the above

9. Which of the following is a major protein system that supports the inflammatory response?
   a) inflammation system
   b) complimentary system
   c) complement system
   d) compliment system
QUESTIONS

Inflammation, infection and immunity

FILL IN THE BLANKS

Fill in the blanks in each statement using the words in this box. Not all of them are required, so choose carefully!

opportunistic
carcinogenesis
infection
T-
latent
B-
viral

10. ________ can occur when a pathogen or disease-causing substance enters the body.

11. ________ infections occur when normal immune and inflammatory responses fail.

12. ________ infections usually occur in people with weakened immune systems.

13. In the cell-mediated immune response, ________ cells respond directly to the foreign antigen.
Inflammation, infection and immunity

QUESTIONS

MATCH THE TERMS

Classify each immune disorder listed below:

A. autoimmune

14. Anaphylaxis ________

B. hypersensitivity

15. HIV disease ________

C. immunodeficiency

16. Rheumatoid arthritis ________

17. Lupus erythematosus ________

18. Allergic rhinitis ________
ANSWERS

TRUE OR FALSE?

1. For infection control, nurses should always wear gloves during patient contact.
   - X
   It is not always necessary to wear gloves during patient contact, sometimes they can actually be a mode of transmission for infection. The most effective infection control measure is a good hand-washing technique.

2. Bacteria contain carbohydrates that may cause infection.
   - X
   Pathogenic bacteria contain two different types of proteins that cause infection: (1) exotoxins – released during cell growth, and (2) endotoxins – released when the bacterial cell wall breaks down. Endotoxins cause fevers and do not respond to antibiotics.

3. Fungi can be classified as yeasts or moulds.
   - ✓
   Fungi are relatively large compared to other microorganisms. Yeasts are round, single cell organisms that can survive with or without oxygen. Moulds are filament-like organisms that require oxygen.

   As part of its natural flora, the body has a range of fungi. However, sometimes they can overproduce, especially when the normal flora is unbalanced. Yeast infections sometimes occur during certain antibiotic treatments because the antibiotic will also attack the normal flora (as well as the bacteria it is targeting).

   Most fungal infections are relatively minor unless the immune system is already comprised (for example, during cancer treatment) or if the infection spreads systemically.

4. Parasitic infections are very common in cold climates.
   - X
   Infections caused by parasites are less common in cold climates but can be very prevalent in hot, moist climates. Most parasitic infections (such as tapeworms) occur in the GI tract, such as tapeworms. Parasites depend on their host for food and a protective environment often to the detriment of the host’s well-being.

5. B-cells are responsible for humoral immunity.
   - ✓
   B-cells trigger the humoral (antibody)-mediated immune response. B-cells originate in the bone marrow and mature to become plasma cells that produce antibodies. Antibodies provide immunity by destroying bacteria and viruses before they enter host cells.
Inflammation, infection and immunity

6 Disorders of the immune system fall into three main categories.

The three types of immune disorders are:

I. autoimmune disorders – when the body initiates an immune response on itself (such as rheumatoid arthritis).
II. hypersensitivity disorders – when an allergen enters the body and causes an over-sensitive immune reaction which may be instant or delayed.
III. immunodeficiency disorders – resulting from a suppressed or deficient immune system (such as AIDS, chronic fatigue syndrome (ME) or during cancer treatment).

MULTIPLE CHOICE

7 Tonsillitis is most commonly caused by:

a) a virus  b) a bacteria  c) a fungus  d) a protozoa

Tonsillitis is an infection most commonly caused by a virus, often those that frequently affect the respiratory system, such as the influenza virus, but it can also be caused by bacteria. Irrespective of the cause, the main symptom is a sore throat, which is often accompanied by red, swollen tonsils which may have visible pus-filled spots, and as a result, the patient may have difficulty swallowing. The patient may also present with a headache, coughing, fatigue, pain in the ears and neck. If the tonsillitis is caused by a virus, there may be associated flu-like symptoms, if it is bacterial, the face may be flushed or have a rash. Most GPs will diagnose tonsillitis based on the symptoms, however, a throat swab may be taken if bacterial infection is suspected and in patients who are immune-compromised or where the infection is recurrent. For an isolated episode, the infection usually subsides within a few days and painkillers may be prescribed to ease symptoms. If the infection is known to be bacterial, an antibiotic may be prescribed to clear the infection. For recurrent infections, surgical removal of the tonsils (tonsillectomy) may be recommended.

8 Pathogens can be transmitted via which of the following routes?

a) airborne  b) arthropods  c) direct and indirect contact  d) all of the above

When the body’s first-line defence mechanisms are overcome by a pathogen, infection can occur. Pathogens can enter the body through the GI tract, the respiratory tract or through the skin. Transmission may be airborne or through direct or indirect contact or pathogens may be spread by arthropods (such as flies, lice, mites).
Which of the following is a major protein system that supports the inflammatory response?

a) inflammation system  b) complimentary system  
**c) complement system**  d) compliment system

The proteins of the complement system continuously circulate in the blood but are usually inactive. When an antigen of a pathogen is encountered by an antibody in the body, the proteins of the complement cascade become activated to initiate and support the inflammatory response. The complement cascade enhances the inflammatory response in two ways: (1) vascular permeability; and (2) chemotaxis (movement of white blood cells to the area of inflammation). It also supports the immune response by encouraging phagocytosis of the foreign bodies and helping breakdown of the foreign cell (cytolysis). *(Hint: to distinguish the spelling, think complement (with an E) enhances the inflammatory response.)*

**FILL IN THE BLANKS**

10 *Infection* can occur when a pathogen or disease-causing substance enters the body.

Infection results when the tissue-destroying microorganisms enter the body and multiply. Infections can result in a minor illness (for example, a cold) but sometimes can induce septicaemia (blood poisoning) which is life-threatening. Septicaemia causes vasodilation and multiple organ dysfunction throughout the body.

11 *Viral* infections can occur when normal immune and inflammatory responses fail.

Viruses are microscopic intracellular parasites that contain genetic material but need a host cell to replicate inside. The virus develops in the host cell and remains there undetected by the immune system. Inside the host cell, the virus releases its genetic material causing infection.

12 *Opportunistic* infections usually occur in people with weakened immune systems.

When the immune system is weakened or compromised, this presents an ‘opportunity’ for pathogens to infect. Situations when the immune system may be weakened include in immuno-suppressed patients (following organ transplant), cancer treatment, antibiotic treatment, malnutrition, AIDS patients and pregnancy.
In the cell-mediated immune response, T-cells respond directly to the foreign antigen.

T-cells respond directly to antigens on the cell surface of invading pathogens. Their response triggers the secretion of lymph proteins (called lymphokines) which destroys target cells such as virus-infected or cancer cells. T-cells can be helper, killer or suppressor T-cells. Helper T-cells stimulate B-cells to mature into plasma cells which synthesize and secrete antibodies. Killer T-cells bind to the cell surface of the invading pathogen and destroy them. Suppressor T-cells reduce the humoral-mediated immune response.

MATCH THE TERMS

Anaphylaxis

Anaphylaxis is an acute allergic reaction triggered by exposure to an antigen. Symptoms include sudden onset and rapid progression of urticaria (hives) and respiratory distress. A severe reaction can also cause vascular collapse, systemic shock and even death.

- **Causes:** There are many possible triggering antigens including vaccine serums, hormones, certain enzymes, anaesthetics, latex, foods, blood/blood products or sensitizing drugs – the most common being penicillin.

- **Pathophysiology:** upon first exposure to the allergen, the immune system becomes sensitized to the allergen and produces specific antibodies (called immunoglobulin E, IgE) which remain on the surface of mast cells. In a second exposure to the allergen, the IgE bind to the allergen and sensitize mast cells which degranulate and release histamine (and other inflammatory mediators). Histamine causes constriction of some smooth muscle, causing vasodilation and increased vascular permeability (Figure 2.1). In an anaphylactic reaction vasodilation is very rapid which causes a sudden drop in blood pressure; this is accompanied by contraction of smooth muscle in the respiratory airways which may result in wheezing and dyspnoea.

- **Signs and symptoms:** immediately after exposure, patients may report a feeling of severe anxiety. This is accompanied by dyspnoea (shortness of breath), weakness, sweating and urticaria.

- **Diagnosis and treatment:** take patient’s history; note signs and symptoms; monitor heart rate, respiratory rate and blood pressure. An injection of adrenaline (epinephrine) should be administered, massage the site of injection to improve the drug distribution in the circulation, if the patient is unconscious, it can be administered by IV.
**Figure 2.1** The mechanism of anaphylaxis

IgE BOUND TO SENSITIZED MAST CELL

- **Allergen**

- **Cell-surface receptor**

SECOND EXPOSURE TO ALLERGEN

- **Allergen binds to IgE**

- ** Causes degranulation and release of histamine and other inflammatory mediators from mast cell**

ANAPHYLACTIC REACTION TO ALLERGEN

- **vasodilation**

Excess histamine and other inflammatory mediators cause:
- smooth muscle constriction, causing bronchoconstriction;
- vasodilation which triggers sudden decrease in blood pressure;
- increased vascular permeability causing oedema and hives on skin surface
HIV disease

Infection with human immuno-deficiency virus (HIV) causes a progressive destruction of the acquired immune system, specifically the T-cells (T4 lymphocytes), meaning the immune response becomes impaired. The infection is characterized by repeated opportunistic infections that progressively weaken the immune system, by destroying helper-T cells, therefore suppressing the acquired immune system. When the number of circulating helper-T cells becomes very low, the immune system is unable to prevent previously harmless (opportunistic) infections. The patient is now said to have developed acquired immuno-deficiency syndrome (AIDS).

- **Causes:** HIV is transmitted in body fluids. Contact with infected blood, tissue, semen or vaginal fluids can cause infection. HIV can cross the placenta and infect a foetus; the newborn may also be infected by its mother during delivery and via breast milk. It is thought that the levels of HIV in other body fluids such as saliva, urine, tears and faeces are insufficient to cause infection.

- **Pathophysiology:** HIV requires a human host cell to replicate. It destroys helper T-cells, causing a gradual reduction in the number of helper T-cells in the body, therefore weakening the body’s acquired immune responses (cell-mediated and humoral). The average time between initial HIV infection and development of AIDS is 8–10 years.

- **Signs and symptoms:** After initial exposure, an infected person may exhibit mild, flu-like symptoms or no symptoms at all. After this primary infection, an individual may remain asymptomatic (exhibit no symptoms) for up to 10 years. As the infection progresses, an infected individual may begin to exhibit opportunistic infections. Repeated opportunistic infections will overwhelm the weakened immune system and the patient develops AIDS. In children, the asymptomatic period is usually much shorter (averaging 17 months); the symptoms they exhibit are similar to adults.

- **Diagnosis and treatment:** A person may remain negative for HIV antibodies for as long as 14 months after initial infection although a positive test for HIV antibodies is usually obtained 3–7 weeks post-exposure. Antibody tests in neonates can be unreliable due to the presence of maternal antibodies for up to 18 months after birth – this can lead to false-positive results in neonatal tests. Routine blood tests monitor helper-T cell count and HIV viral load in the blood, these are used to evaluate the level of immunosuppression. There is no cure for HIV or AIDS but several drugs exist to slow the progression of the disease. Anti-retroviral drugs (called highly active anti-retroviral therapy, HAART treatment) reduce replication of the virus and hence slow HIV progression. Anti-infective drugs can also be prescribed to limit the number of opportunistic infections that will progressively weaken the immune system. Anti-neoplastic agents can be used to treat the rare cancers often associated with HIV and AIDS.
Rheumatoid arthritis

A chronic systemic inflammatory autoimmune disorder causing destruction of the peripheral joints and surrounding muscles tendons, ligaments and blood vessels. Rheumatoid arthritis (RA) patients can undergo spontaneous remission but also unpredictable exacerbation of their condition. It is more prevalent in females than males and usually affects patients between the ages of 20 and 50.

**Causes:** The cause remains unknown but genetics, hormones and infections are thought to be involved. Viruses are thought to trigger RA in people who have a genetic susceptibility for the disease.

**Pathophysiology:** Exposure to an antigen triggers the formation of altered antibodies that the body does not recognize as its own. Since they are recognized as foreign, the body then forms another antibody against them, called rheumatoid factor, which causes inflammation. This inflammation eventually causes cartilage damage. The continued immune response includes activation of the complement cascade which stimulates release of inflammatory mediators and this exacerbates joint destruction.

**Signs and symptoms:** Initially symptoms are non-specific, including fatigue, malaise, weight loss and persistent low-grade fever. As the inflammation progresses more specific symptoms are observed such as swelling around the joint which may be warm and/or painful, these symptoms occur particularly in the fingers, but also in wrists, elbows, knees and ankles.

**Diagnosis and treatment:** No test will provide a definitive diagnosis of RA but there are useful indicative tests:

- X-ray – soft-tissue swelling and bone demineralization are observable, and X-rays can be used to determine extent of cartilage and bone destruction.
- Testing for presence of rheumatoid factor – although this is not sufficient to diagnose the disease, it is useful in determining prognosis. The prognosis worsens as nodules and vasculitis (inflammation of blood or lymph vessels) develops.

Since it is a chronic illness RA usually requires lifelong treatment and sometimes surgery on joints that are painful or damaged. Treatments to reduce pain and inflammation help to maintain quality of life. Non-steroidal anti-inflammatory drugs (NSAIDs) are the main type of painkiller used since they decrease inflammation and relieve joint pain. Immunosuppressants are sometimes used early in the disease to halt its progression. Tumour necrosis factor (TNF) alpha-blockers are a relatively new class of drug that is proving effective in treating adults and children with RA and other autoimmune disorders. Patients are also encouraged to practise certain exercises to maintain joint function.
Lupus erythematosus  

A chronic, inflammatory, autoimmune disorder affecting the connective tissues. There are two forms of lupus erythematosus: systemic and discoid. Systemic lupus erythematosus (SLE) affects multiple organs and can be fatal, it is the more common form of the condition. It is more common in females, particular those of Afro-Caribbean origin. Discoid lupus erythematosus only affects the skin.

- **Causes:** The exact cause of SLE is unknown. It is thought to be a combination of genetic and environmental factors. Possible triggers include viruses, infection, stress, prolonged use of medication, sunlight exposure, hormones and endocrine changes including (puberty, menopause and childbirth).
- **Pathophysiology:** The body produces antibodies against its own cells which suppress its normal immune responses. A feature of SLE is that patients produce antibodies against many different types of its own tissues such as red blood cells, white blood cells, platelets, and even its own organs.
- **Signs and symptoms:** Symptoms of lupus can vary. Some people only experience a mild form of the condition, whereas others are more severely affected and may develop serious complications. As with other autoimmune disorders, there are no specific symptoms. SLE primarily causes fatigue, joint pain and skin rashes (particularly the ‘butterfly rash’ over the cheeks and bridge of the nose), as the immune system attacks the body’s tissue and cells. Certain blood disorders may be detected such as anaemia, leucopenia, lymphopenia, and thrombocytopenia. An elevated erythrocyte sedimentation rate (ESR), may also occur.
- **Diagnosis and treatment:** SLE can be difficult to diagnose because symptoms vary between patients. Active disease is diagnosed by decreased serum complement levels since complement levels decrease during active SLE episode.

Drugs are the main form of treatment for SLE. In mild conditions, NSAIDs are sufficient to control the arthritis and joint pain. Topical corticosteroids can be applied to treat skin lesions. Hydroxychloroquine (normally used to treat malaria) is also effective in treating some symptoms of SLE, such as skin rashes, joint and muscle pain and fatigue, although there can be complications associated with this type of medication. Patients are also advised to protect themselves from the sun.

Allergic rhinitis  

When airborne allergens are inhaled, they may trigger an immune response in the upper airway, this may cause inflammation of the nasal mucous membranes (rhinitis) or conjunctivitis (inflammation of the membrane lining inside the eyelids and covering the eyeball). Seasonal allergic rhinitis is commonly known as hay fever.
**Inflammation, infection and immunity**

- **Causes:** The airborne allergens that trigger the disorder include dust, animal fibres, pollen (triggers hay fever) or work-related allergens (such as flour, dust or latex).

- **Pathophysiology:** Allergic rhinitis is a hypersensitivity response to an environmental allergen. The nasal and mucous membranes swell and may lead to secondary sinus or middle ear infections. Complications include pneumonia or bronchitis.

- **Signs and symptoms:** This can cause cold-like symptoms, such as sneezing and runny nose; patients may also experience headache or sinus pain and have an itchy throat. Dark circles may develop under the eyes as a result of venous congestion in the maxillary sinuses.

- **Diagnosis and treatment:** Analysis of nasal secretions may show elevated levels of the white blood cells. The best advice for any allergy involves controlling symptoms and avoiding allergens known to trigger infection. Antihistamines are the main type of drug prescribed to reduce the runny nose and watery eyes symptoms although some antihistamines can have a sedative effect. Non-sedating antihistamines are also available that reduce the side effects.