6.3 Defence Against Infectious Diseases

Immune System

Define pathogen

Pathogens are disease-causing agents (e.g. microorganisms, viruses and prions)

Distinguish between bactericidal and bacteriostatic drugs

Bactericidal drugs kill the invading bacteria whereas bacteriostatic drugs suppress its potential to reproduce

Outline how Florey and Chain demonstrated the antibiotic properties of penicillin

The use of penicillin as a viable antibiotic was shown by Florey & Chain (1940)

Mice injected with a pathogen (streptococcus), while half the mice were also injected with penicillin

Untreated mice died from bacterial infection, whereas mice treated with penicillin survived

Explain why antibiotics are effective against bacteria but not viruses

Antibiotics are compounds that inhibit or kill bacteria by targeting the structures or metabolic pathways of prokaryotes (not eukaryotes) - viruses don't have metabolism and so are not affected by antibiotics

List five types of white blood cells

Neutrophils - rapid response to microbial infections

Lymphocytes - specific (adaptive) immune response

Monocytes / Macrophages - longer lasting response to microbial infections

Eosinophils - target multicellular parasites (too big to phagocytose)

Basophils - involved in inflammation (similar to mast cells)

Describe the function and organisation of the lymphatic system

The lymphatic system is a transport system that protects the body by producing and filtering lymph

Lymph contains white blood cells and arises from the drainage of fluid from blood and tissues

Lymph is filtered at lymph nodes, where pathogens are removed before fluid is returned to venous circulation

Major lymphatic organs include the spleen, tonsils, thymus and adenoids

First Line of Defence

Outline the role of surface barriers in the physical protection against infection

Skin protects external structures and is a thick and dry region composed predominantly of dead cells

Mucous membranes protects internal cavities and is a thin region composed of living cells that secrete mucus

Sebaceous glands secrete biochemical agents / acids to inhibit bacterial growth

Commensals (gut bacteria) prevent the colonisation of harmful pathogens in the digestive tract

Describe, with the aid of the diagram, the process of clotting

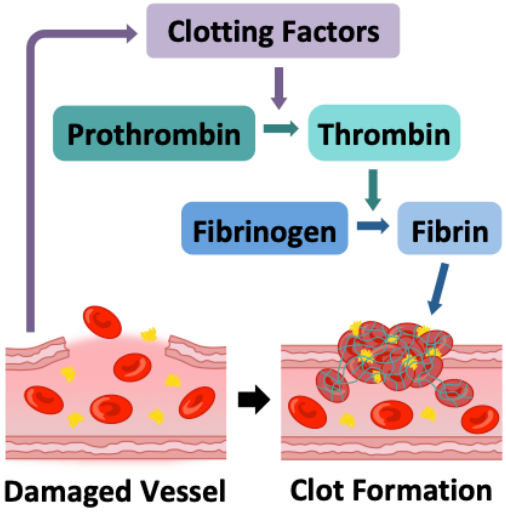
Injured cells and platelets release clotting factors

Factors convert prothrombin (inactive) into thrombin (active)

Thrombin converts fibrinogen (soluble) into fibrin (insoluble)

Fibrin forms a mesh of insoluble fibres that trap blood cells

Clotting factors also cause platelets to become sticky and form a solid plug (clot)



Describe the causes and consequences of clotting in the coronary arteries

Blood clots form in coronary arteries when the vessels are damaged by cholesterol build-up (atherosclerosis)

The restricted blood flow increases pressure in the artery, leading to damage to the arterial wall (plaques)

If the plaque ruptures, blood clotting is triggered, forming a thrombus that restricts blood flow

Clot formation in coronary arteries leads to coronary thrombosis and heart attacks

Second Line of Defence

Identify five non-specific defence mechanisms the body uses to combat infection

1. Phagocytosis - pathogens are engulfed and destroyed by phagocytic leukocytes
2. Inflammation - blood flow is increased to site of infection to increase leukocyte access
3. Complement proteins - activate a cascade that promotes pathogen detection and destruction
4. Fever - increases body temperature to assist in pathogenic destruction
5. Natural killer cells - non-specifically target viral-infected cells

Outline the process and purpose of inflammation

When tissue damage occurs, mast cells and basophils release histamine which causes local vasodilation and increases capillary permeability to improve the recruitment of leukocytes to the region

Outline how phagocytic leukocytes ingest and present pathogens in the blood and body tissues

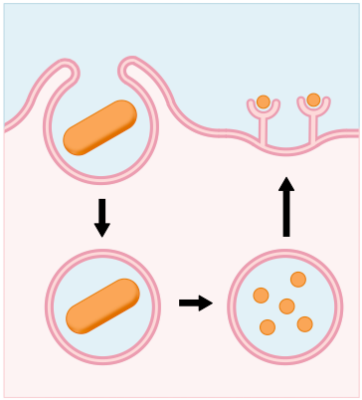
Phagocytes (macrophages) circulate in blood but move to tissue upon infection

Pathogens are engulfed by the phagocyte and internalised in a vesicle

The vesicle may then fuse with the lysosome to digest the pathogen

Antigenic fragments from the pathogen are presented on the macrophage

These fragments are then presented to lymphocytes in order to help stimulate the production of specific antibodies



Third Line of Defence

Identify the two key properties of the adaptive immune system

Adaptive: It can differentiate between pathogens and target a response that is specific to a given pathogen

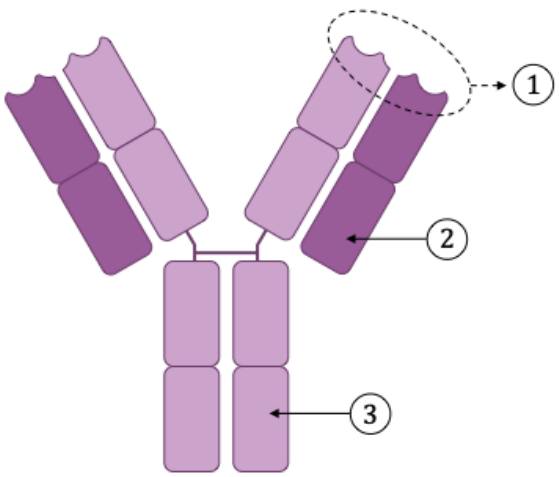
Memory: It can respond rapidly upon re-exposure to a specific pathogen, preventing disease symptoms

Distinguish between antigens and antibodies

Antigen: Antigens are molecules that are capable of inducing an immune response

Antibody: Antibodies are proteins produced by lymphocytes that recognise and neutralise specific antigens

Label the structure of an antibody



1. Variable region (antigen binding site / epitope)
2. Light chain
3. Heavy Chain

What is the alternative name for an antibody?

Immunoglobulin

Explain antibody production (humoral immunity)

The antigenic fragments of pathogens are presented on the macrophages

Lymphocytes are a class of white blood cells that develop in the bone marrow

Macrophages present antigen fragments to helper T lymphocytes (TH cells)

TH cells release cytokines to activate an antigen-specific B lymphocyte (B cell)

The B cell divides and differentiates into plasma cells that produce antibodies

A small proportion of clones develop into memory cells (for long-term immunity)

Immune System Disorders

Identify three types of immune system disorders

1. Hypersensitivity disorders (i.e. allergic reactions)
2. Autoimmune disorders (e.g. multiple sclerosis, lupus)
3. Immunodeficiency disorders (e.g. HIV / AIDS)

Describe the effects of HIV on the immune system

The human immunodeficiency virus (HIV) is a retrovirus that infects helper T cells

HIV is integrated into the genome of the helper T cells and after years of inactivity the virus spreads

Infected TH cells are lysed (destroyed) in order to release the virus from the cells

This results in reduced immunity (AIDS) as antibody production is compromised

Define allergen

An environmental substance that triggers an immune response despite not being intrinsically harmful

Describe the role of histamine in the allergic response

When a B cell encounters the allergen, it differentiates into plasma cells and makes a specific antibody (IgE)

The IgE antibodies attach to mast cells, effectively 'priming' them towards the allergen

Upon re-exposure, the IgE-primed mast cells release large amounts of histamine which causes inflammation