

11.1 Antibody Production & Vaccination

Antibody Production

Identify five mechanisms of disease transmission

1. Direct contact - the transfer of pathogens via physical association
2. Exchange of body fluids - via blood transfusions or sexual intercourse
3. Contamination - ingestion of pathogens growing on, or in, edible food sources
4. Airborne - certain pathogens can be transferred in the air via coughing and sneezing
5. Vectors - intermediary organisms that transfer pathogens without developing symptoms themselves

State the term used to describe a disease that can cross species barriers and identify a specific example

Diseases from animals that can be transmitted to humans are called zoonotic diseases (or zoonoses)
 Examples include rabies (dogs), certain strains of influenza (e.g. bird flu) and the bubonic plague (rats)

Distinguish between an antigen and an antibody

Antigen: A substance that the body recognises as foreign and that will elicit an immune response

Antibody: A protein produced by B lymphocytes (and plasma cells) that is specific to a given antigen

Describe the system of antigenic presentation on human red blood cells (i.e. the ABO blood system)

	Type A	Type B	Type AB	Type O
Antigen on blood cells	A antigen	B antigen	Both A and B antigens	No antigens
Antibodies in bloodstream	Anti-B antibody	Anti-A antibody	No antibodies	Anti-A and Anti-B antibodies
Blood donors	Can take A or O but not B or AB	Can take B or O but not A or AB	Can take any blood (universal acceptor)	Can only take O (universal donor)

Distinguish between class I and class II MHC proteins

	MHC I	MHC II
Where found	All nucleated body cells (not RBCs)	Antigen-presenting cells (e.g. macrophages, B cells)
Antigens presented	Endogenous antigens	Exogenous antigens
Cells presented to	Cytotoxic T cells (and TH cells)	B cells (and TH cells)

Differentiate between humoral and cell mediated immunity

Humoral Immunity

The pathway by which antibodies are produced by plasma cells to target exogenous antigens

Antigens are presented on the MHC class II markers of macrophages to helper T cells

The helper T cells then secrete cytokines to activate the appropriate B lymphocytes

The specific B cell divide and differentiate (clonal selection) to form antibody producing plasma cells

Cell Mediated Immunity

The pathway that does not result in antigen production but instead targets endogenous antigens

Cancerous and virus-infected cells involve the body's own cells and thus are not recognised as foreign

These cells present antigenic fragments as a complex with their own self markers (MHC class I)

When helper T cells identify these cells, they stimulate cytotoxic T cells that lyse the compromised cells

State 5 specific actions of antibodies and outline how they contribute to the overall immune response

- P. Precipitation - Soluble pathogens become insoluble and precipitate
- A. Agglutination - Cellular pathogens become clumped for easier removal
- N. Neutralisation - Antibodies may occlude pathogenic regions
- I. Inflammation - Antibodies may trigger an inflammatory response
- C. Complement activation - Complement proteins perforate membranes



Collectively, the action of antibodies enhance the immune system by aiding the detection (opsonisation) and removal of pathogens by the phagocytic leukocytes of the innate immune system (macrophages)

Define polyclonal activation

Pathogens contain multiple distinct antigenic fragments on their surface and hence a single pathogen is likely to stimulate several different T and B lymphocytes to produce a variety of specific antibodies

Immunity

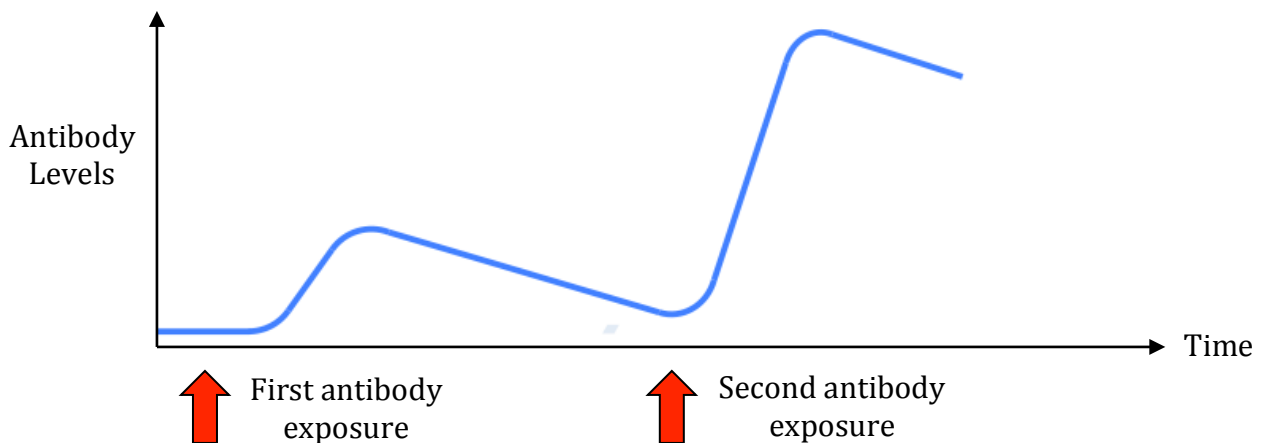
Describe how immunity occurs

When a B lymphocyte divides to form plasma cells, a small proportion will differentiate into memory cells

Memory cells are long living and survive for many years, producing low levels of circulating antibodies

If re-infection occurs, memory cells produce antibodies faster so disease does not develop (immunity)

Complete the following graph to show antibody response



Define active and passive immunity

Active: Active immunity involves the production of antibodies by the body itself

and the subsequent development of memory cells

Passive: Passive immunity results from the acquisition of antibodies from another source

and hence memory cells are not developed

Give a practical example for each of the following types of immunity

Natural Active Immunity: Challenge and response to a pathogenic infection

Natural Passive Immunity: Newborns receiving antibodies via a mother's breast milk

Artificial Active Immunity: Vaccination (treatment with an attenuated pathogen)

Artificial Passive Immunity: Transfusion of monoclonal antibodies (e.g. for treatment of rabies)

Explain the principle of vaccination

Vaccines contain attenuated forms of a pathogen that cannot cause disease

Vaccinations induce active immunity by stimulating production of memory cells

When exposed to actual pathogen, the memory cells trigger faster/stronger secondary immune response

Vaccines confer long-term immunity, however booster shots may be periodically required

Define herd immunity

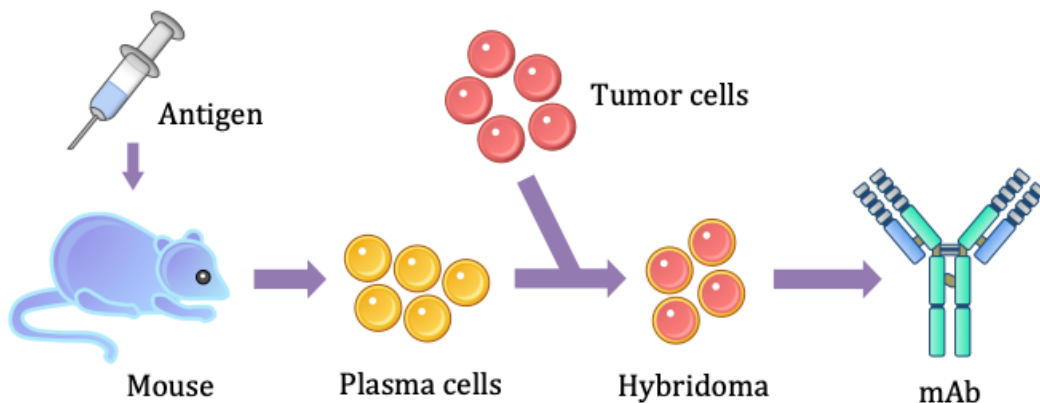
Herd immunity is when individuals who are not immune to a pathogen are protected from exposure

by the large amounts of immune individuals (usually >95%) within the community

Identify three aspects of the smallpox virus that allowed for a successful vaccination campaign

1. Easily identifiable infection (overt clinical symptoms)
2. Infection period was short lived and virus was stable (did not mutate)
3. Transmission required direct contact and there were no animal vectors or reservoirs to sustain the virus

Describe, with the aid of the diagram, the production of monoclonal antibodies



An animal (e.g. mouse) is injected with antigen to produce specific plasma cells

Plasma cells are removed and fused with tumor cells capable of endless divisions

The resulting hybridoma will synthesise large quantities of the specific antibody (monoclonal)

Identify one diagnostic and one therapeutic use for monoclonal antibodies

Diagnostic: Detection of pregnancy (anti-hCG antibodies)

Therapeutic: Treatment of cancers or rapid infections (e.g. rabies)