



# Immune response

Lec.11.

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# Introduction

- ▶ An immune response is a reaction which occurs within an organism for the purpose of defending against foreign invaders. These invaders include a wide variety of different microorganisms including viruses, bacteria, parasites, and fungi which could cause serious problems to the health of the host organism if not cleared from the body.
- ▶ There are two distinct aspects of the immune response, **the innate and the adaptive**, which work together to protect against pathogens.
- ▶ **The innate branch**—the body's first reaction to an invader—is known to be **a non-specific** and quick response to any sort of pathogen.
- ▶ Components of the innate immune response include **physical barriers like the skin and mucous membranes, immune cells such as neutrophils, macrophages, and monocytes, and soluble factors including cytokines and complement.**

# Introduction

- ▶ On the other hand, **the adaptive branch** is the body's immune response which is catered against specific antigens and thus, it takes longer to activate the components involved. The adaptive branch **include cells such as dendritic cells, T cell, and B cells as well as antibodies**, which directly interact with antigen and are a very important component for a strong response against an invader.
- ▶ The first contact that an organism has with a particular antigen will result in the production of **effector T and B cells** which are activated cells that defend against the pathogen.
- ▶ The production of these effector cells as a result of **the first time exposure is called a primary immune response. Memory T and memory B cells are also produced.**
- ▶ re-exposed to the same pathogen, **a secondary immune response** will be able to respond in both **a fast and strong manner because of the memory cells from the first exposure.**
- ▶ **Vaccines** introduce a weakened, killed, or fragmented microorganism in order to **evoke a primary immune response.** This is so that in the case that an exposure to the real pathogen occurs, the body can rely on the secondary immune response to quickly defend against it.

## Primary Immune Response

After initial exposure to a foreign antigen, there is a lag phase where B cells are differentiating into plasma cells, but not yet producing antibodies. Antibody generation can take anything from 2 days to several months.

Low quantities of antibodies are normally secreted.

After a while, the amount of antibody decreases to minimal levels.

Antibodies are mostly IgM, but some IgG antibodies are produced.

## Secondary Immune Response

If a previously encountered antigen enters the body again, a few days up to several years later, a secondary immune response develops. This time, the lag phase is greatly reduced, to about 3-4 days.

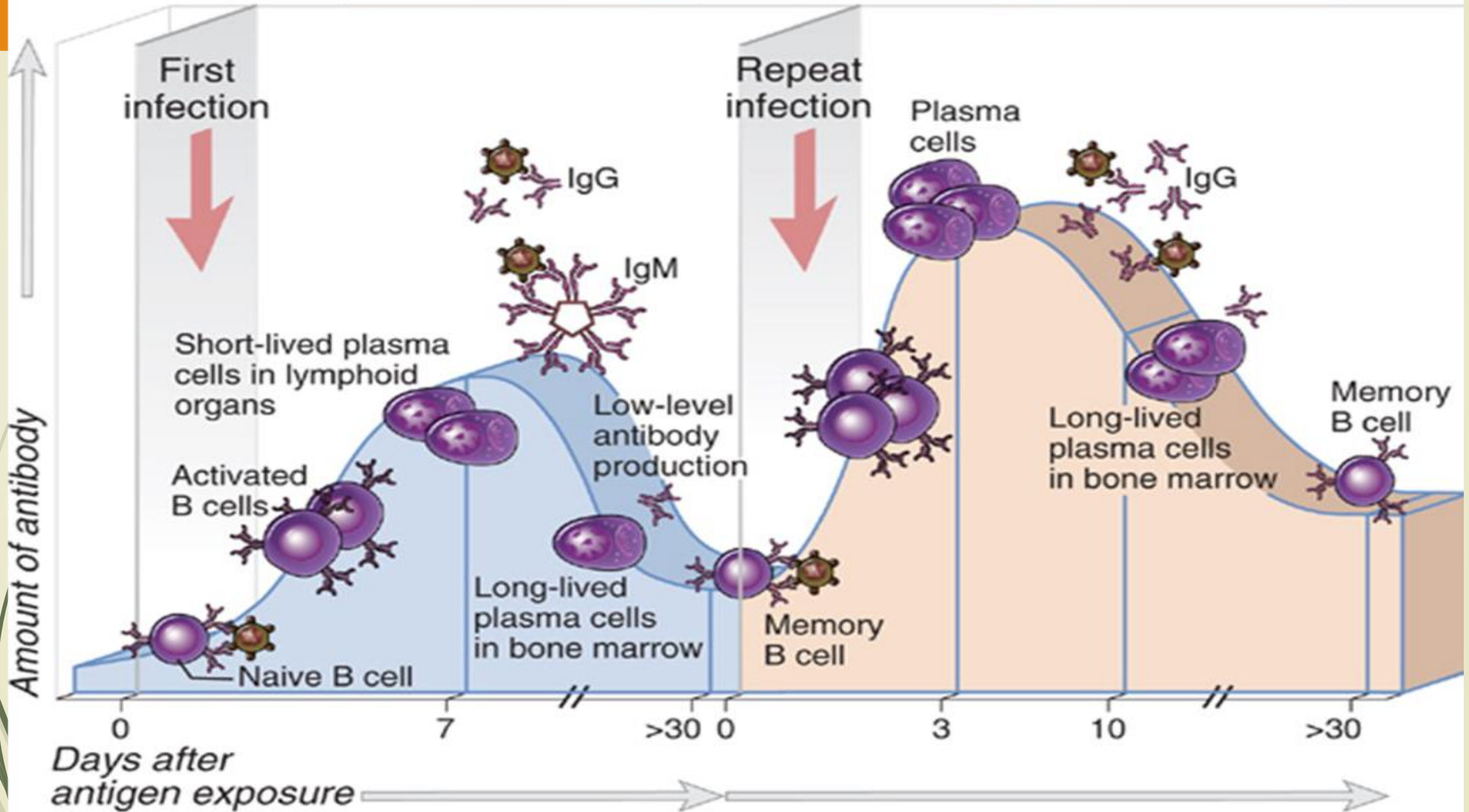
High levels of antibodies are produced.

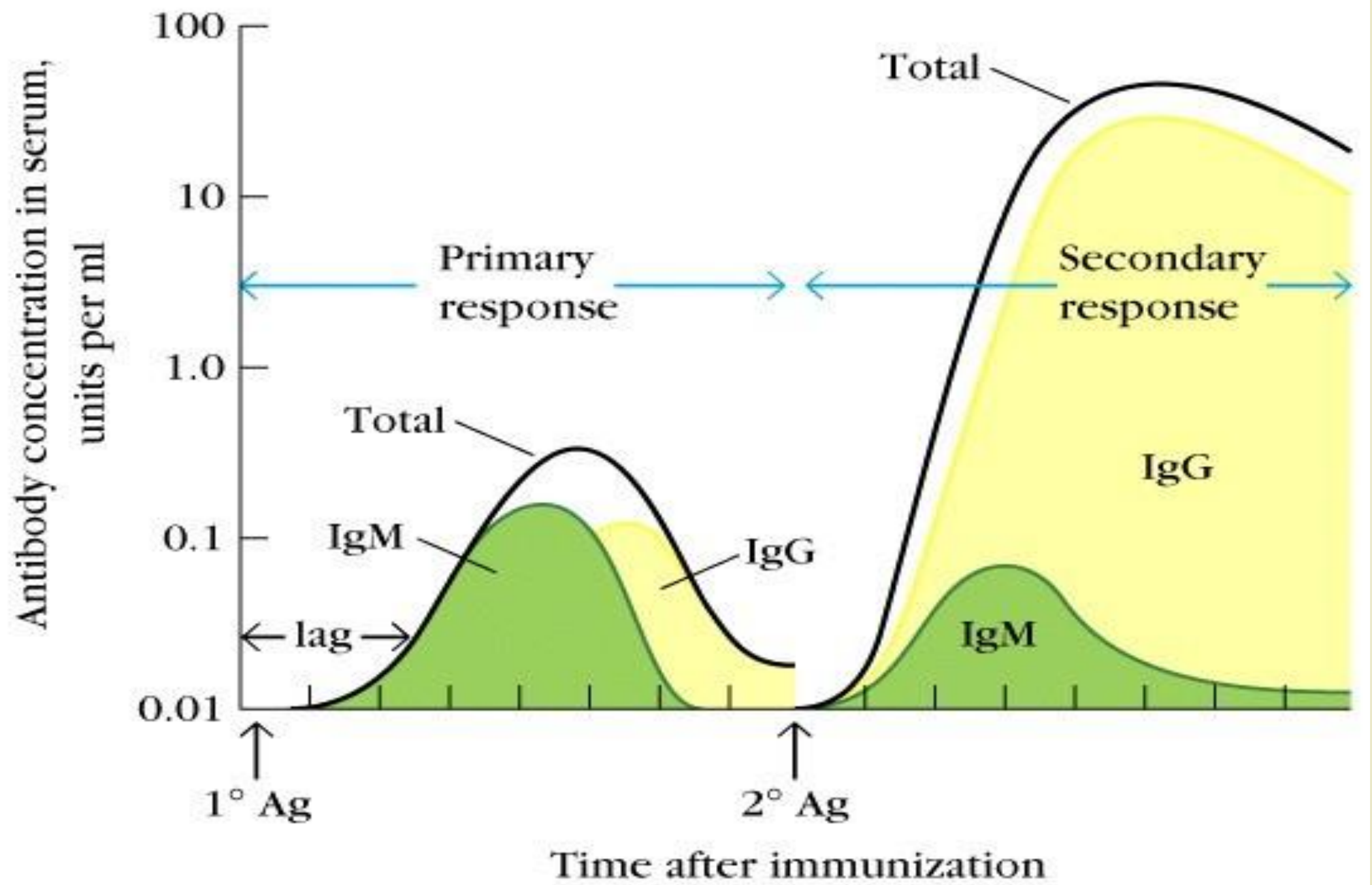
Antibody levels remain elevated for longer.

IgGs are the main antibody secreted, with some small amounts of IgM sometimes.

# Primary antibody response

# Secondary antibody response





# Innate immune response

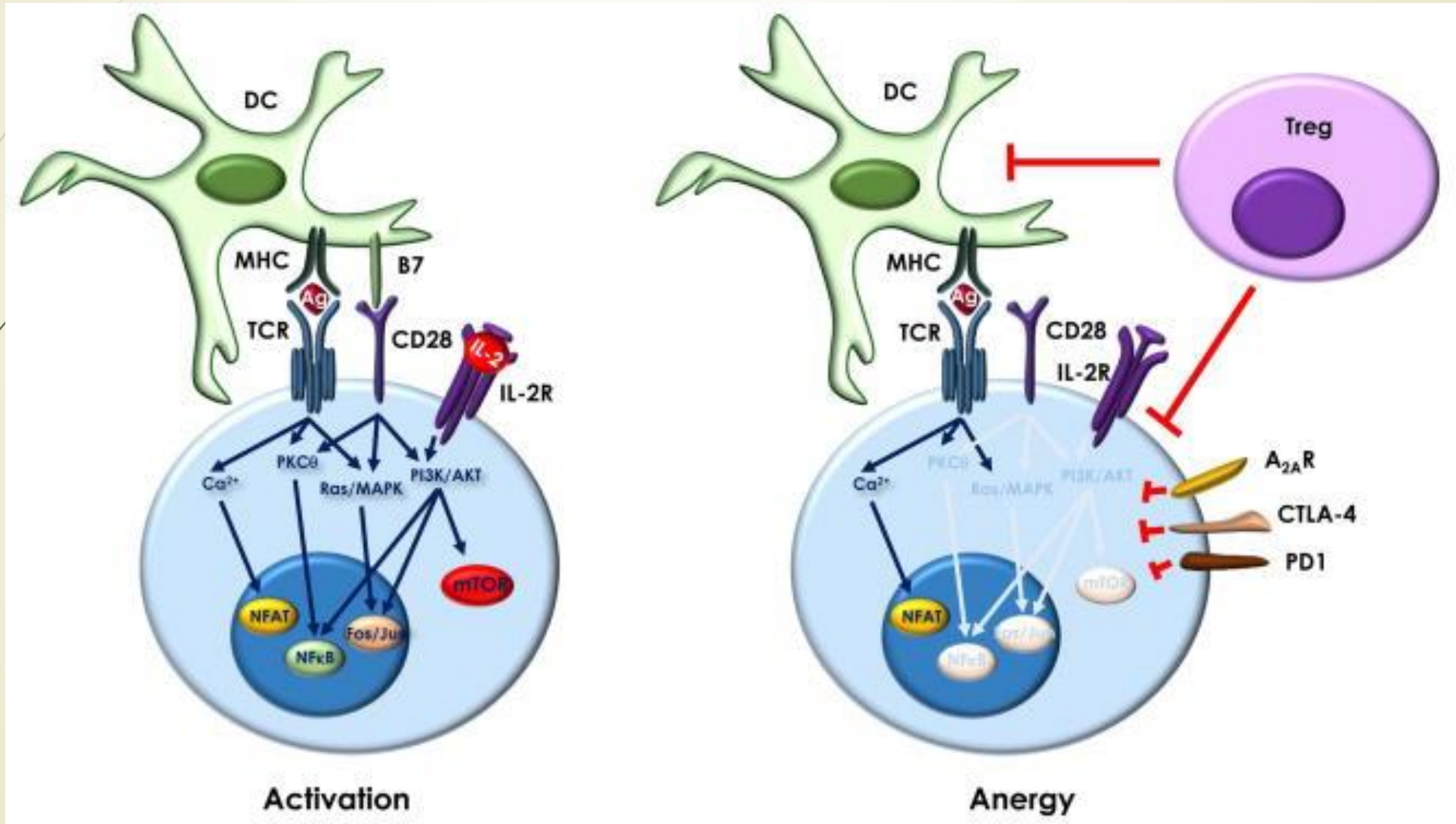
- ▶ Pathogens are recognized and detected via **pattern recognition receptors (PRR)**. These receptors are structures on the surface of **macrophages** which are capable of binding foreign invaders and thus **initiating cell signaling** within the immune cell. Specifically, **the PRRs identify pathogen-associated molecular patterns (PAMPs)** which are integral structural components of pathogens. Examples of PAMPs include the **peptidoglycan cell wall or lipopolysaccharides (LPS)**, both of which are essential components of bacteria and are therefore evolutionarily conserved across many different bacterial species.
- ▶ **The signaling pathway** which allows for the **transcription factor NF- $\kappa$ B** to enter the nucleus of the macrophage and initiate the transcription and eventual secretion of various cytokines such as **IL-8, IL-1, and TNF $\alpha$** . Release of these cytokines is necessary for the entry of **neutrophils** from the blood vessels to the infected tissue. Once neutrophils enter the tissue, like macrophages, they are able to phagocytize and kill any pathogens or microbes.
- ▶ **Complement, classical pathway** is triggered when IgG or IgM is bound to its target antigen on either the pathogen cell membrane or an antigen-bound antibody.
- ▶ **The alternative pathway** is activated by foreign surfaces such as viruses, fungi, bacteria, parasites, etc., and is capable of auto activation due to “**tickover**” of C3. The **lectin pathway** is triggered when mannose binding lectin (MBL).
- ▶ Though the pathways are activated differently, the overall role of the complement system is to **opsonize pathogens and induce a series of inflammatory responses that help to combat infection.**

# Adaptive immune response

- ▶ The cells of the adaptive immune system are extremely specific because during early developmental stages the **B and T cells develop antigen receptors that are specific to only certain antigens.**
- ▶ **Activation of naïve helper T cells** occurs when **antigen-presenting cells (APCs)** present foreign antigen via **MHC class II molecules on their cell surface.** These **APCs include dendritic cells, B cells, and macrophages** which are specially equipped not only with MHC class II but also with **co-stimulatory ligands** which are recognized by co-stimulatory receptors on helper T cells. Without the co-stimulatory molecules, the adaptive immune response would be inefficient and T cells would become **anergic.**
- ▶ Once **helper T cells are activated, they are able to activate naïve B cells in the lymph node.** However, B cell activation is a two-step process. **Firstly, B cell receptors,** which are just Immunoglobulin M (IgM) and Immunoglobulin D (IgD) antibodies specific to the particular B cell, must bind to the antigen which then results in internal processing so that it is presented on the MHC class II molecules of the B cell. Once this happens a T helper cell which is able to identify the antigen bound to the MHC interacts with its co-stimulatory molecule and activates the B cell. As a result, **the B cell becomes a plasma cell which secretes antibodies that act as an opsonin against invaders.**
- ▶ the adaptive immune response is also known for **immunological memory.** After encountering an antigen, the immune system produces **memory T and B cells** which allow for a speedier, more robust immune response in the case that the organism ever encounters the same antigen again.



# Activated and anergy T cell

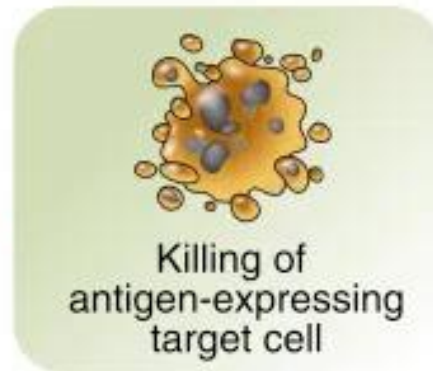
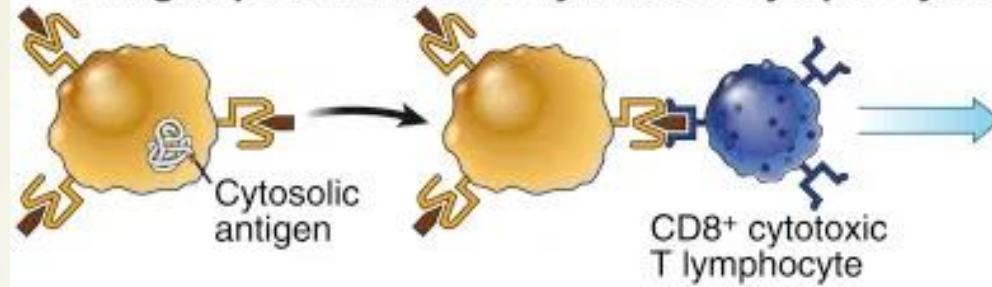


Antigen uptake  
or synthesis

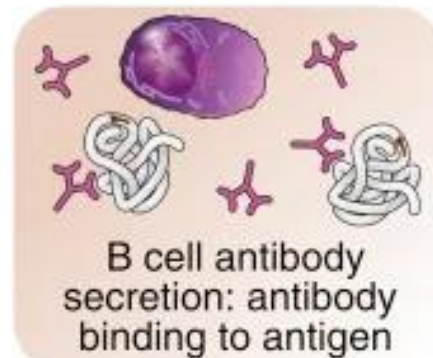
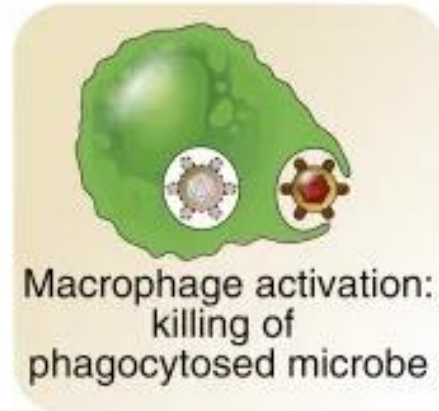
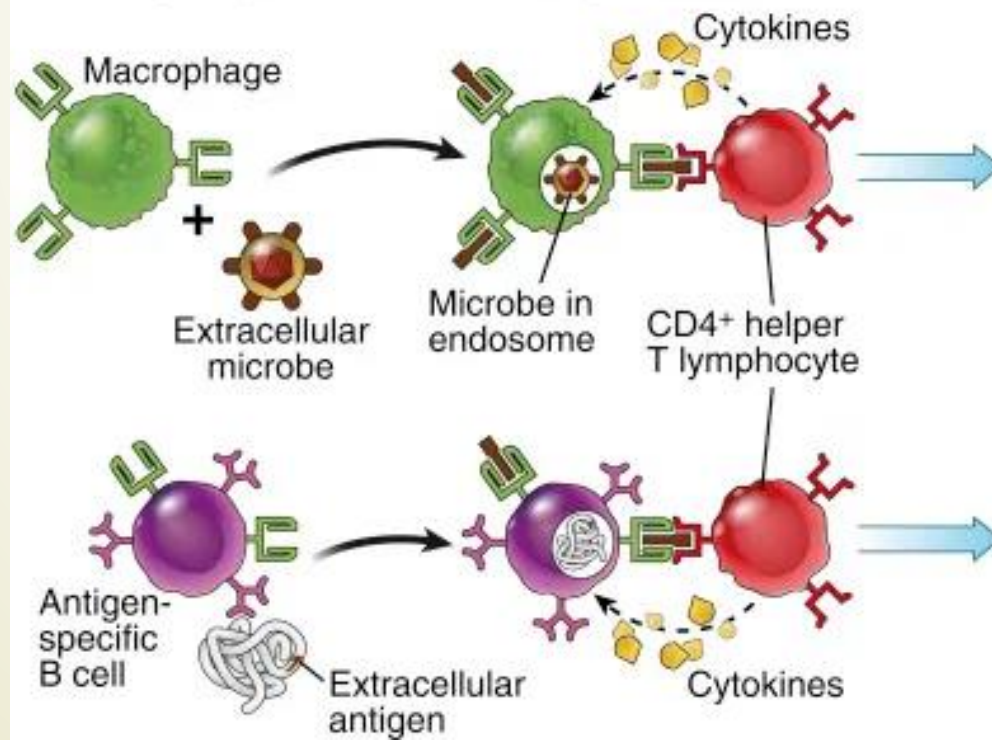
Antigen  
presentation

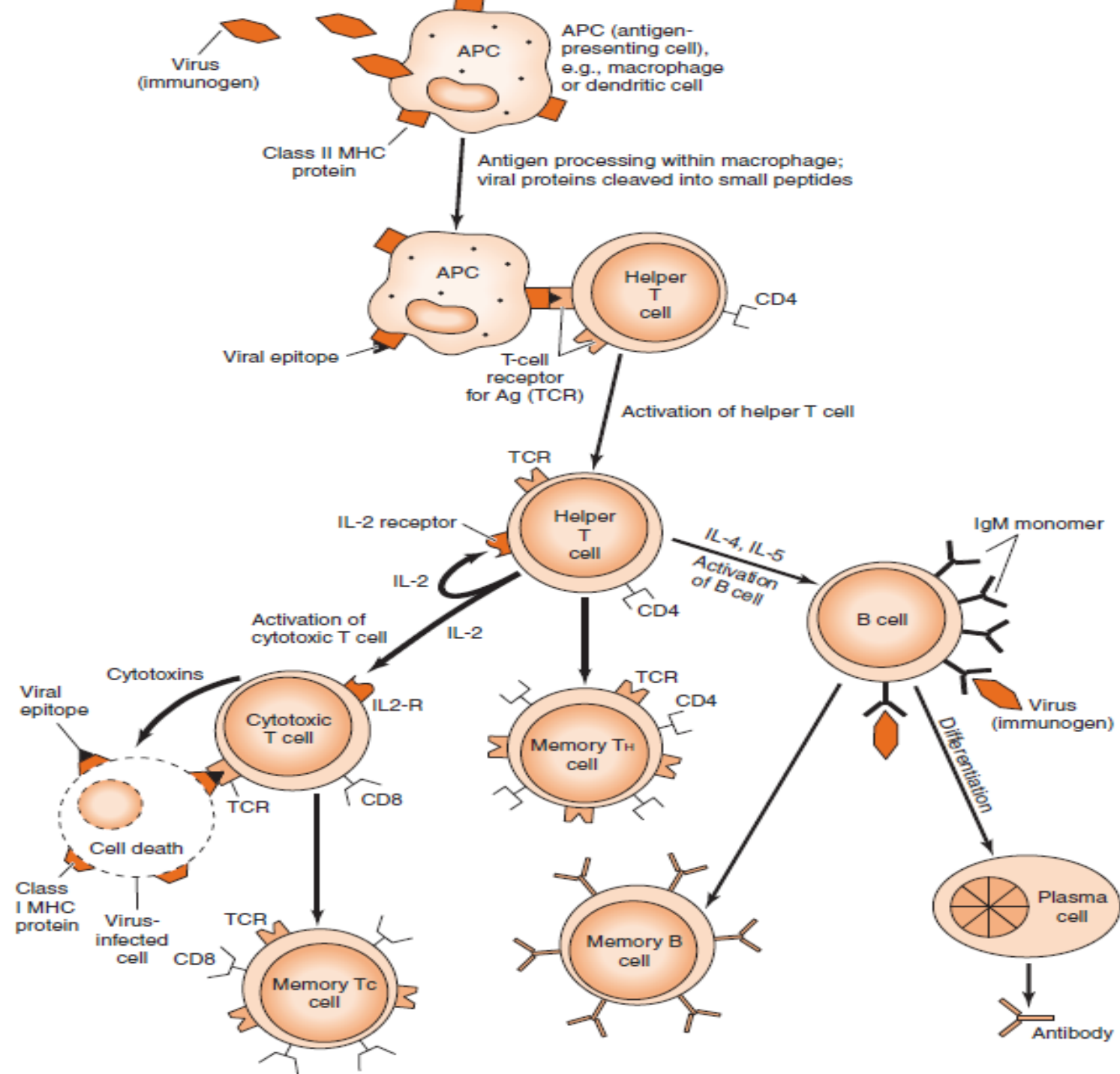
T cell–dependent  
effector functions

**(A) Class I MHC pathway:  
antigen presentation to cytotoxic T lymphocytes**



**(B) Class II MHC pathway:  
antigen presentation to helper T cells**







**Thank you**