

# General Biology

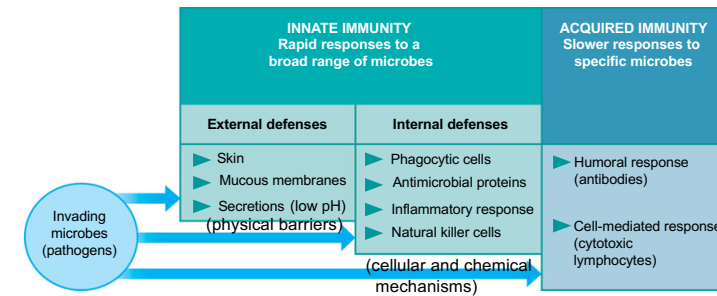
Course No: BNG2003  
Credits: 3.00

## 11. The Immune System

### Repetition

Prof. Dr. Klaus Heese

- A summary of innate and acquired immunity

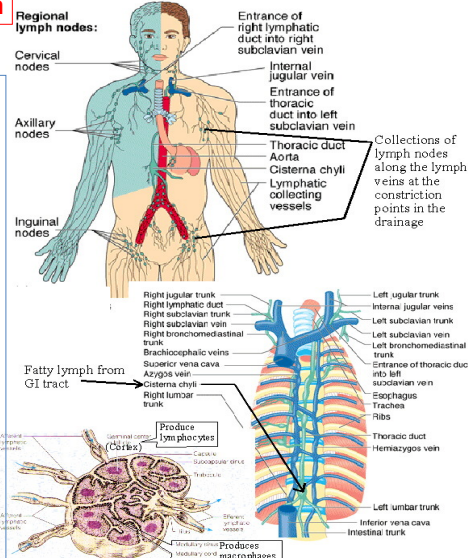


## The Lymphatic System

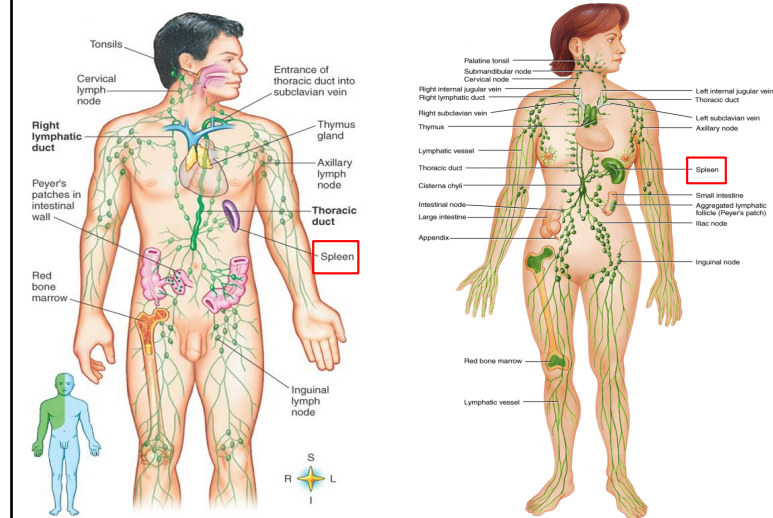
Lymph is essentially recycled blood plasma

The lymphatic system has multiple interrelated functions:

- It is responsible for the removal of interstitial fluid from tissues
- It absorbs and transports fatty acids and fats (lipids) as chyle from the digestive system
- It transports white blood cells to and from the lymph nodes into the bones
- The lymph transports antigen-presenting cells (APCs), such as dendritic cells, to the lymph nodes where an immune response is stimulated.



Lymphatic system: Functions: 1) Remove excess interstitial fluid; 2) Transport of dietary lipids; 3) Specific immunity (as compared to non-specific immunity).



### Primary lymphoid organs

The central or primary lymphoid organs generate **lymphocytes** from immature progenitor cells.

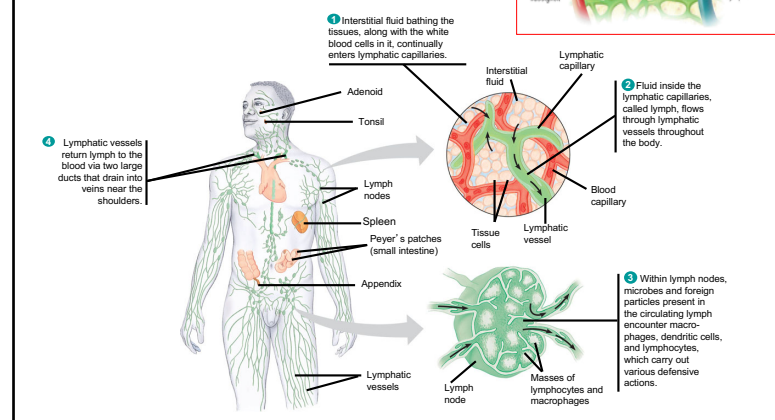
The **thymus** and the **bone marrow** constitute the **primary lymphoid tissues** involved in the production and early selection of lymphocytes.

### Secondary lymphoid organs

**Secondary or peripheral lymphoid organs** maintain mature naive **lymphocytes** and initiate an **adaptive immune response**. The **secondary/peripheral lymphoid organs** are the **sites of lymphocyte activation by antigen**. Activation leads to clonal expansion and affinity maturation. Mature lymphocytes recirculate between the blood and the peripheral lymphoid organs until they encounter their specific antigen.

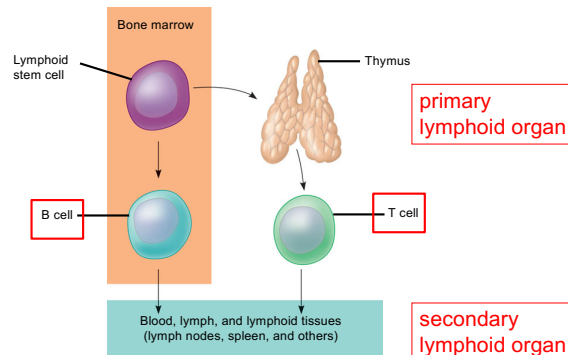
**Secondary lymphoid tissue** provides the environment for the foreign or altered native molecules (antigens) to interact with the lymphocytes. It is exemplified by the **lymph nodes**, and the **lymphoid follicles in tonsils**, **Peyer's patches**, **spleen**, **adenoids**, **skin**, etc. that are associated with the mucosa-associated lymphoid tissue (MALT).

- The lymphatic system plays an active role in defending the body from pathogens



### Lymphocyte Development as part of acquired immunity

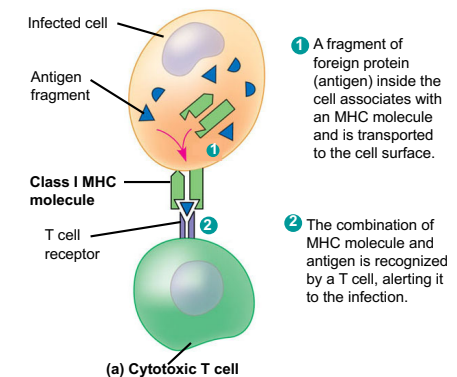
- Lymphocytes arise from stem cells in the bone marrow
- Newly formed lymphocytes are all alike but they later develop into B cells or T cells, depending on where they continue their maturation



### T cells

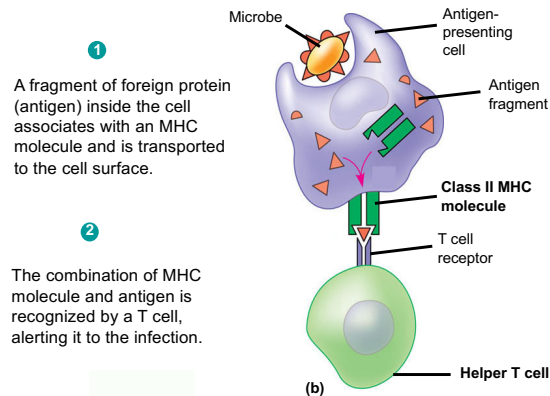
- Depending on their source peptide antigens are handled by different classes of **MHC molecules**

- Class I MHC** molecules, found on almost all nucleated cells of the body display peptide antigens to cytotoxic T cells

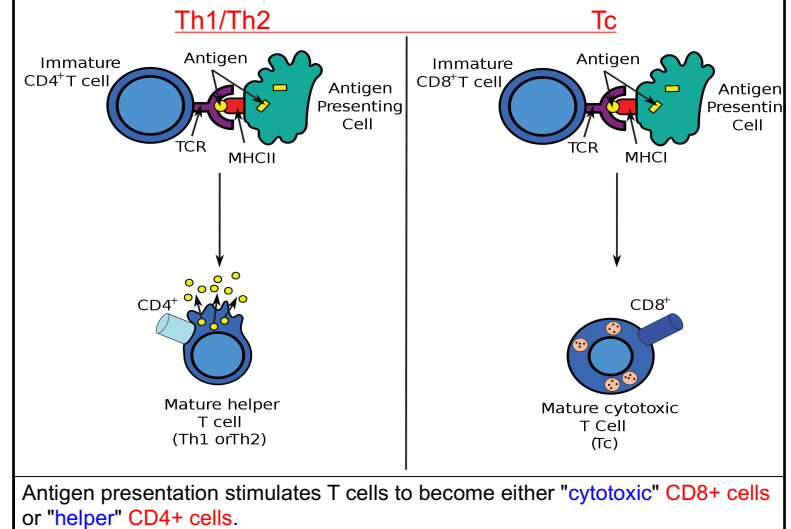


## T cells

- Class II MHC molecules, located mainly on dendritic cells, macrophages, and B cells display antigens to helper T cells



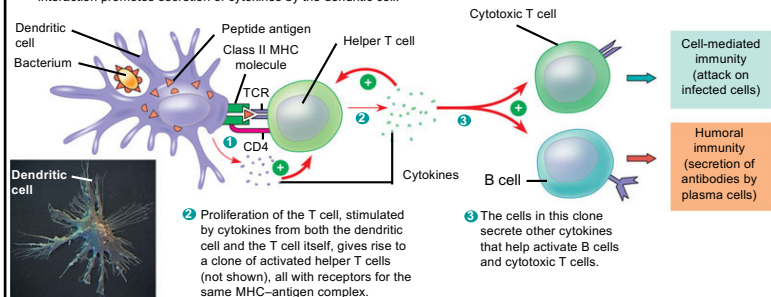
## general overview of T (CD4/CD8) cell activation



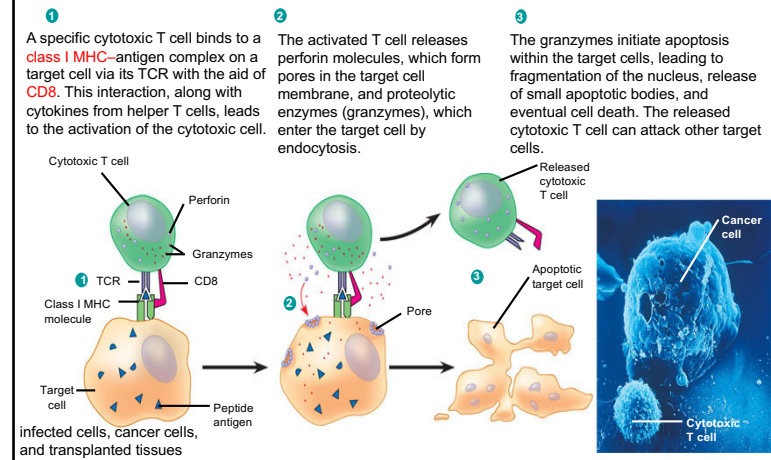
- Helper T cells produce CD4, a surface protein that enhances their binding to class II MHC molecule–antigen complexes on antigen-presenting cells
- Activation of the helper T cell then occurs
- Activated helper T cells secrete several different cytokines that stimulate other lymphocytes

### The role of helper T cells in acquired immunity

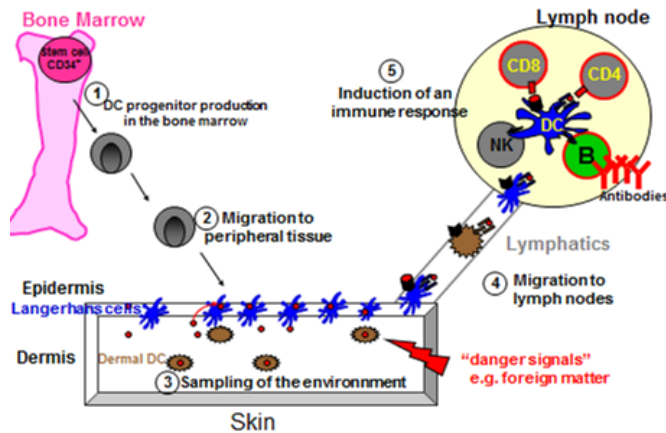
- After a dendritic cell engulfs and degrades a bacterium, it displays bacterial antigen fragments (peptides) complexed with a class II MHC molecule on the cell surface. A specific helper T cell binds to the displayed complex via its TCR with the aid of CD4. This interaction promotes secretion of cytokines by the dendritic cell.



- The activated cytotoxic T cell secretes proteins that destroy the infected target cell

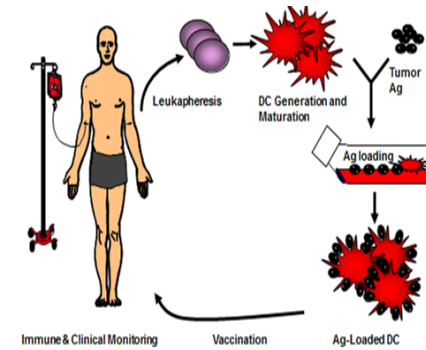


## Dendritic Cells : Center of the “Immuniverse”



## How can we use Dendritic Cells as therapeutic Vaccines?

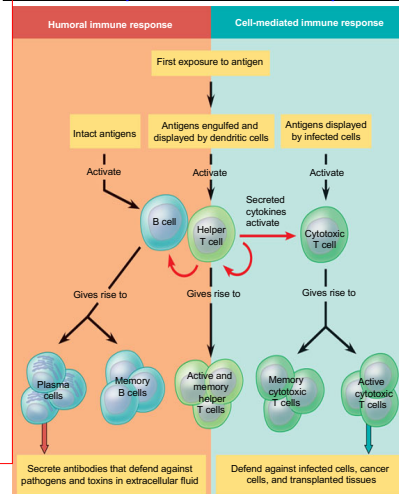
- Methods
- obtain DC from patient blood
- Load DC with tumor components
- Return DC to patients



- **Humoral and cell-mediated immunity** defend against different types of threats
- **Acquired immunity** includes two branches:
  - i) the **humoral** immune response involves the activation and clonal selection of **B cells**, resulting in the production of **secreted antibodies**,
  - ii) the **cell-mediated** immune response involves the activation and clonal selection of **cytotoxic T-cells**

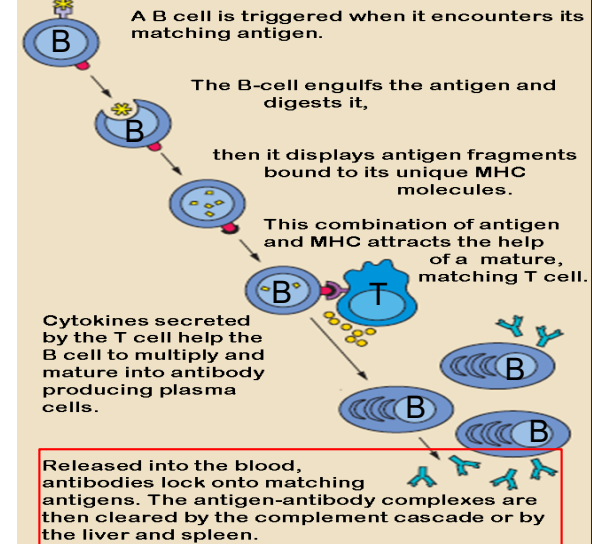
mammals immature B cells are formed in bone marrow

The roles of the major participants in the **acquired immune response**



## Mechanism of action

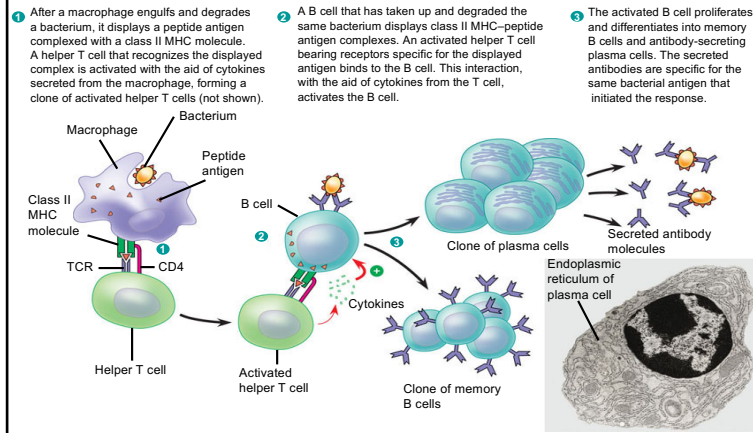
### T cell-dependent B cell activation





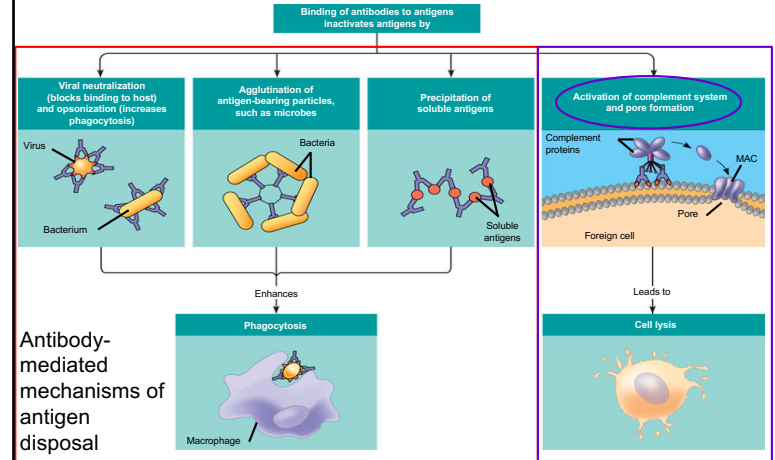
## Mechanism of action - T cell-dependent B cell activation

- Activation of B cells is aided by cytokines and antigen binding to helper T cells; the clonal selection of B cells generates antibody-secreting plasma cells, the effector cells of humoral immunity

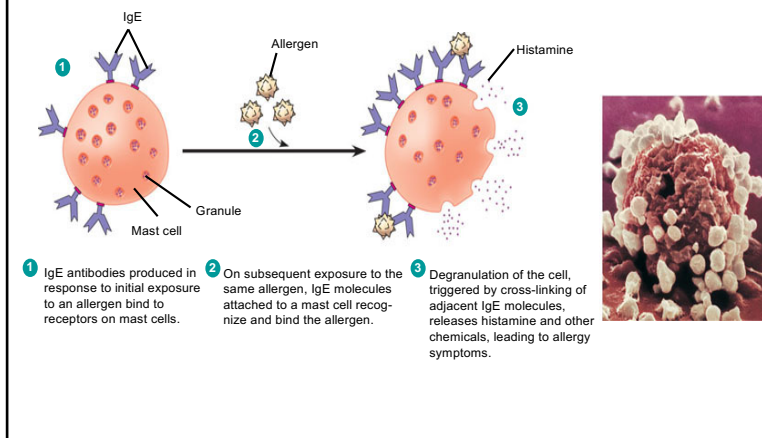


## Antibody-Mediated Disposal of Antigens

- The binding of antibodies to antigens is also the basis of several antigen disposal mechanisms; it leads to elimination of microbes by phagocytosis and complement-mediated lysis



## The Allergic Response



## Basophil activation: both C3a and C5a have anaphylatoxin activity, directly triggering degranulation of mast cells / basophils as well as increasing vascular permeability and smooth muscle contraction.

