

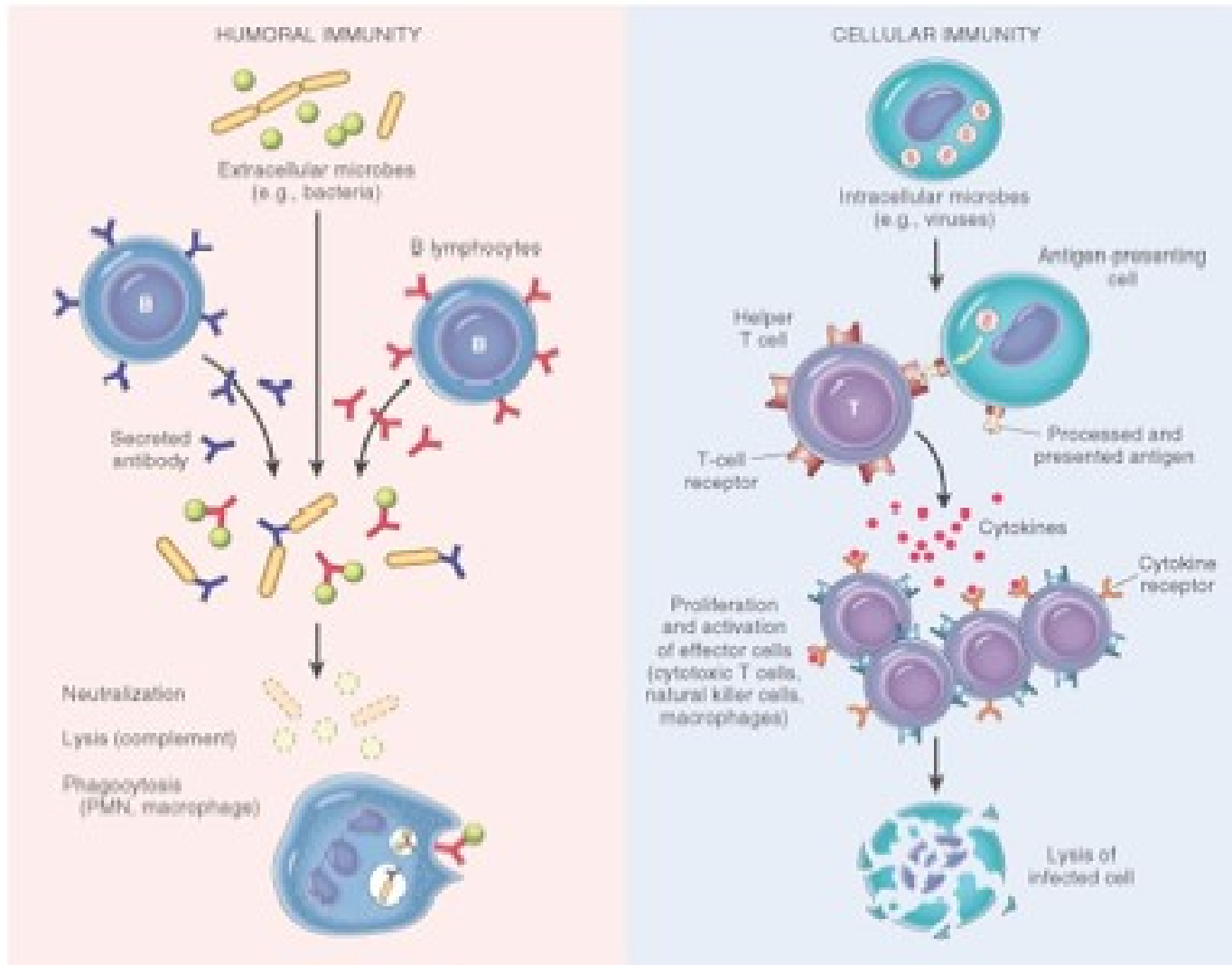
# **Cell Mediated Immunity**

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College of Medicine & Medical City  
King Saud University**

**Reference**  
**Kuby Immunology 8<sup>th</sup> Edition**  
**Chapter 8**  
**Chapter 11**

# Objectives

- To describe antigen recognition by T cells
- To describe the pathways involved in processing endogenous and exogenous antigens
- To discuss self MHC restriction in Ag presentation to T cells
- To describe the induction of cell mediated immunity (Chronic Inflammation)



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Other cells

# Cell Mediated Immunity (CMI)

- T cells (lymphocytes) via their receptors bind to the surface of other cells (Antigen Presenting Cells) that display the processed antigen and trigger a response
- Mononuclear cell inflammatory process usually associated with chronic inflammations

# Antigen Presenting cells

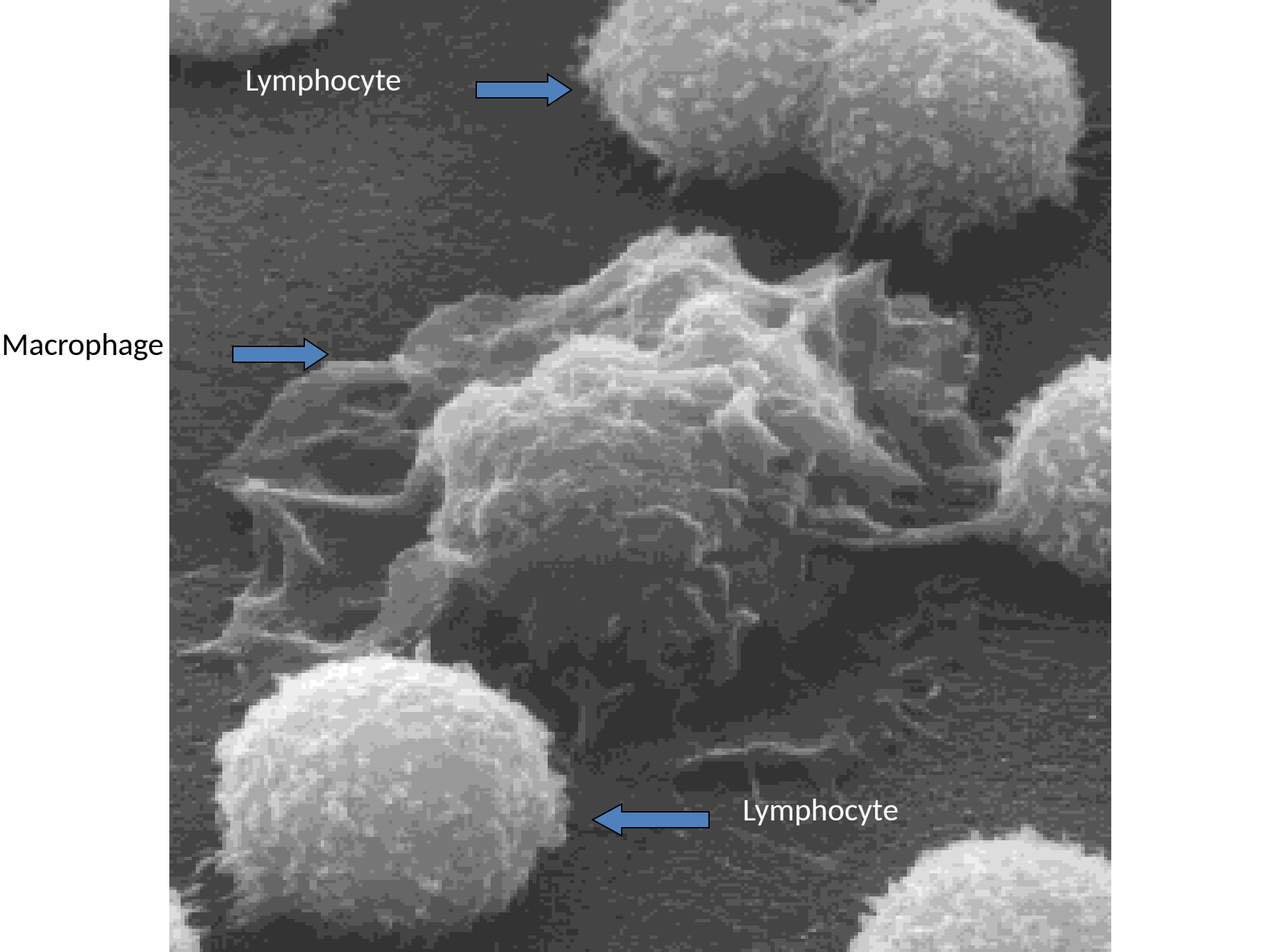
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**Monocytes : Peripheral blood**

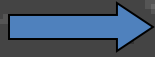
**Macrophages : Tissues**

**Dendritic cells : Lymphoid tissues, skin  
(Langerhans cells)**

**B-cells : Lymphoid tissue, Blood**



Lymphocyte



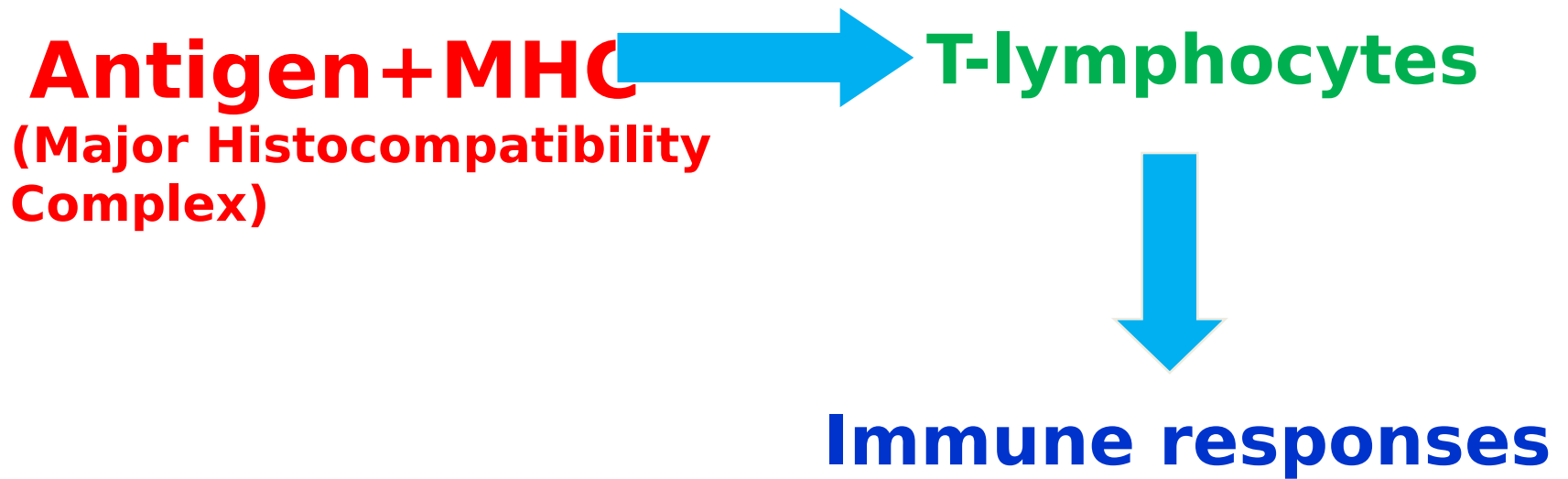
Macrophage



Lymphocyte



# Cell-Mediated Immunity (CMI)



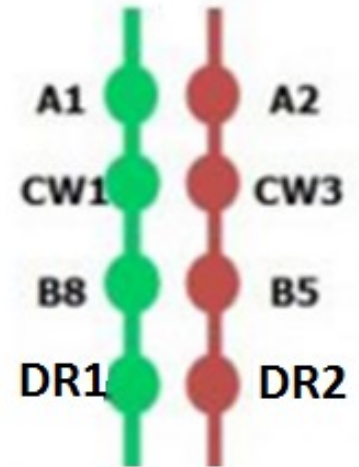


# Major Histocompatibility Complex (MHC)

- Major histocompatibility complex (MHC) proteins were discovered for the first time when tissue transplantation started
- The success of tissue and organ transplantation depends upon the match of donor's and recipient's "*human leukocyte antigens*" (HLA) encoded by HLA genes
- Genes for HLA proteins are clustered in the MHC complex located on the short arm of chromosome 6

# MHC

- Each individual has two “*haplotypes*” ie, two sets of these genes one paternal and one maternal



- MHC Class I molecules are found on the surface of virtually all nucleated cells
- MHC Class II molecules are normally present on the surface of antigen presenting cells such as:
  - Macrophages,
  - Dendritic cells
  - B cells

# Biologic Importance of MHC

- Antigen recognition

- T cytotoxic (CD8) cells kill virus infected cells in association with class I MHC proteins
- T helper (CD4) cells recognize antigen in association with class II MHC proteins

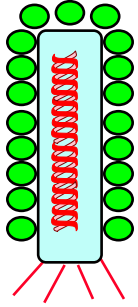
**This is called MHC restriction**

- Transplantation

- Success of organ transplant is determined by compatibility of the MHC genes

**1. Endogenous antigen  
(Cytoplasm)**

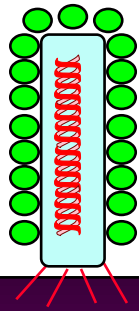
**2. Exogenous antigen  
(Membrane Bound)**



**Virus**

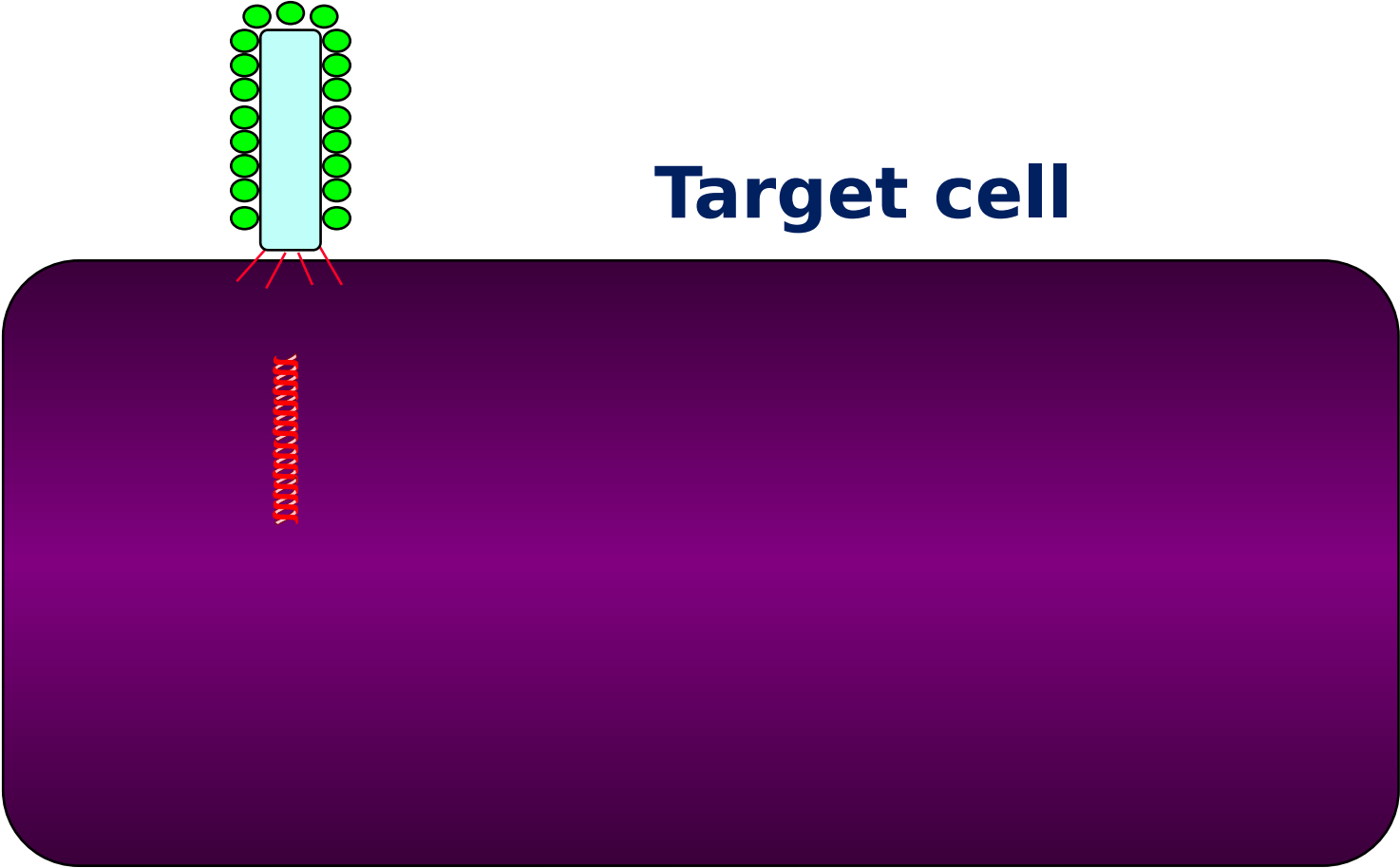
**Target cell**

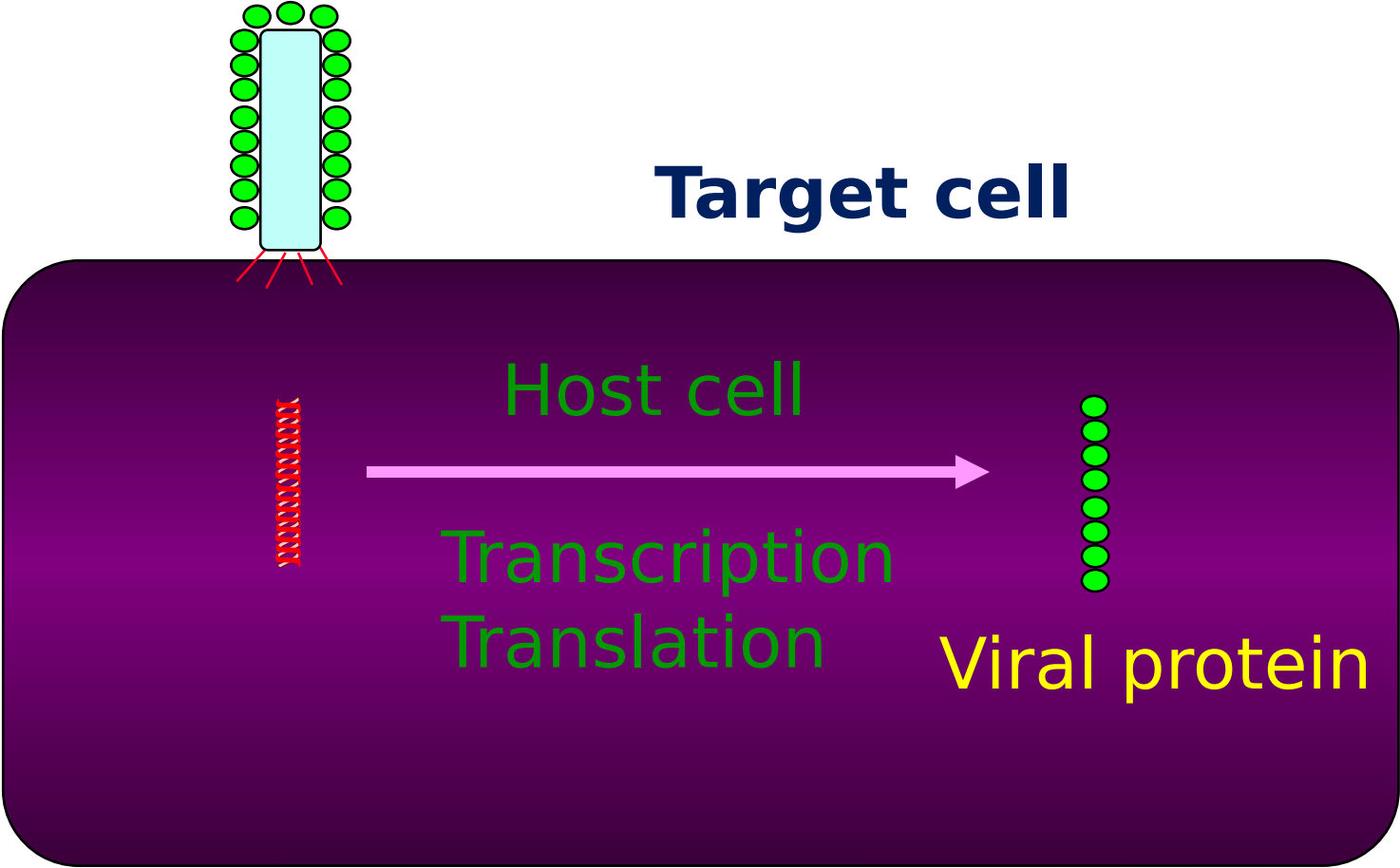




**Target cell**

**Target cell**





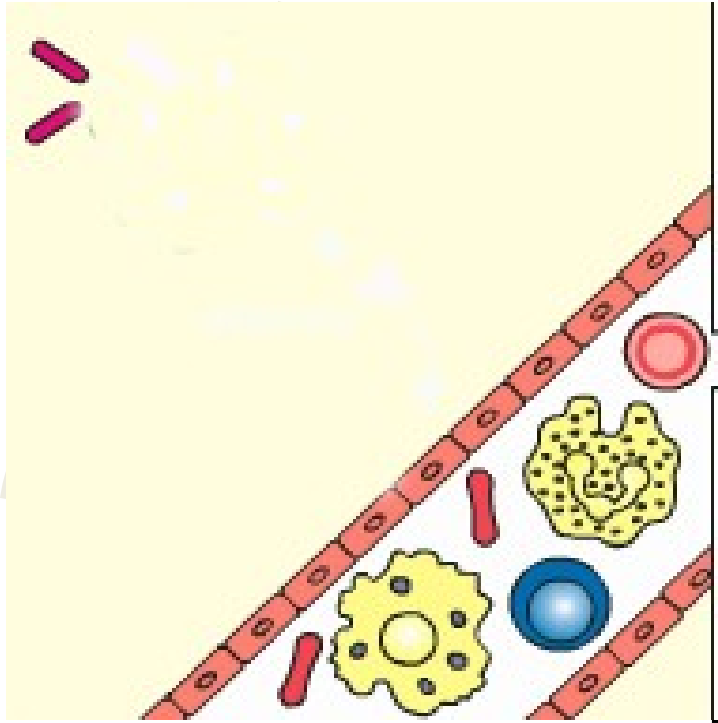
**Target cell**

Host cell

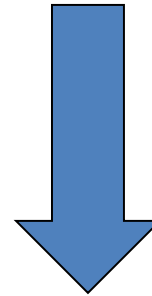
Transcription  
Translation

Viral protein

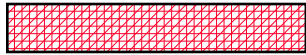




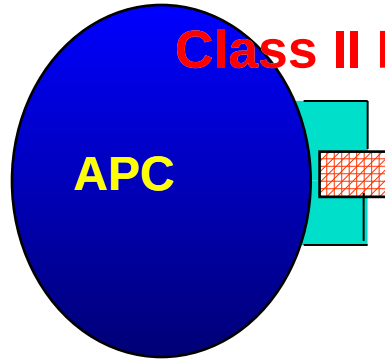
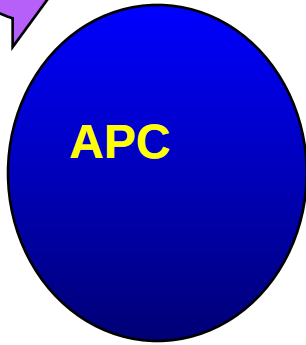
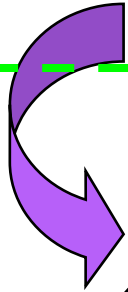
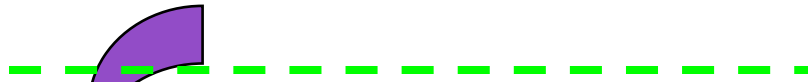
# Exogenous antigen



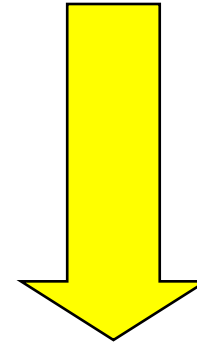
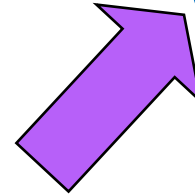
# Cell-mediated immunity



**Exogenous antigen**



**CD4+ T-lymphocytes  
(CD4+ cells)**



**CMI**

**(Cell Mediated Immunity)**

**Antigen presenting cells**

Monocytes/Macrophages

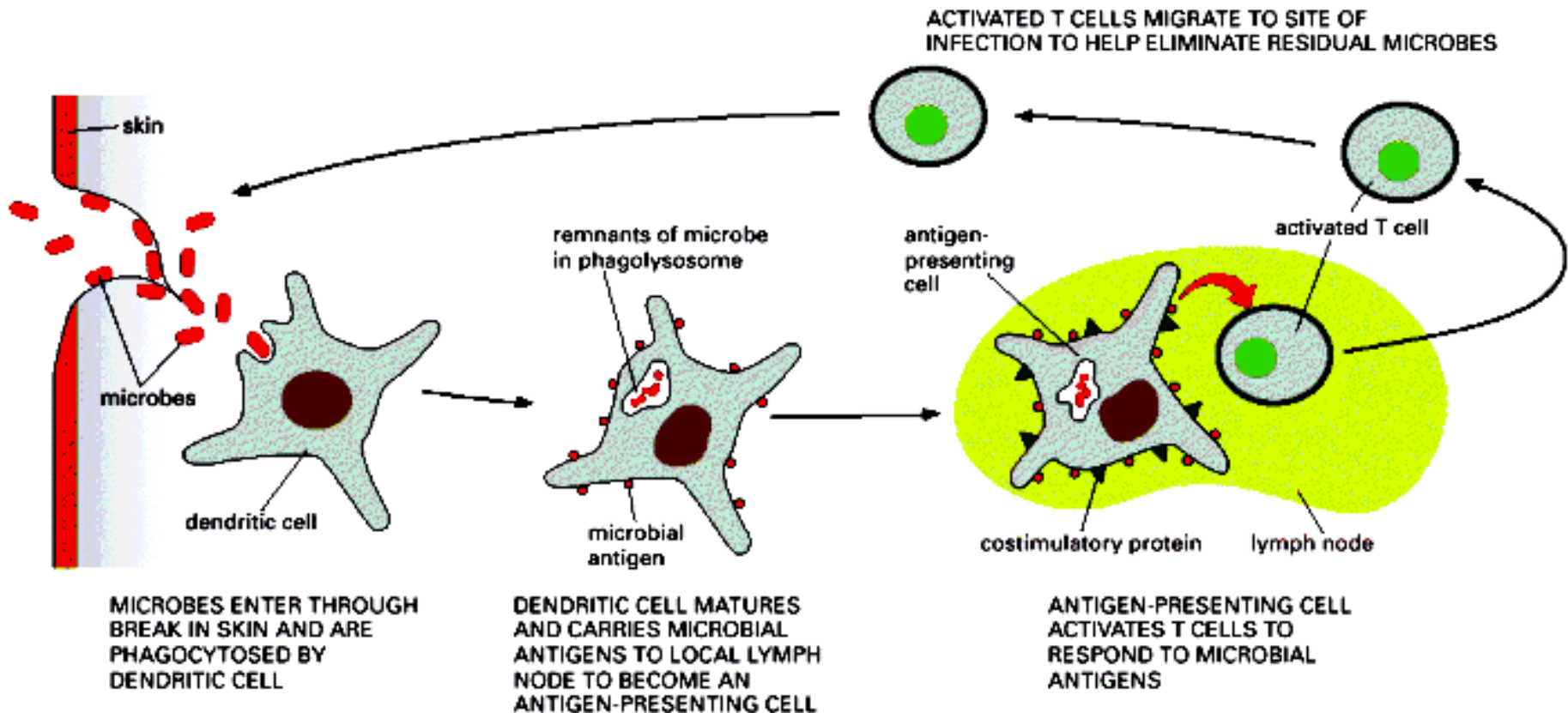
Dendritic cells

Langerhans cells

B-cells

# Antigen Presenting Cells

- Dendritic cells and macrophages digest invading microbe and then present the antigen of the microbe to lymphocytes in lymphoid organs.

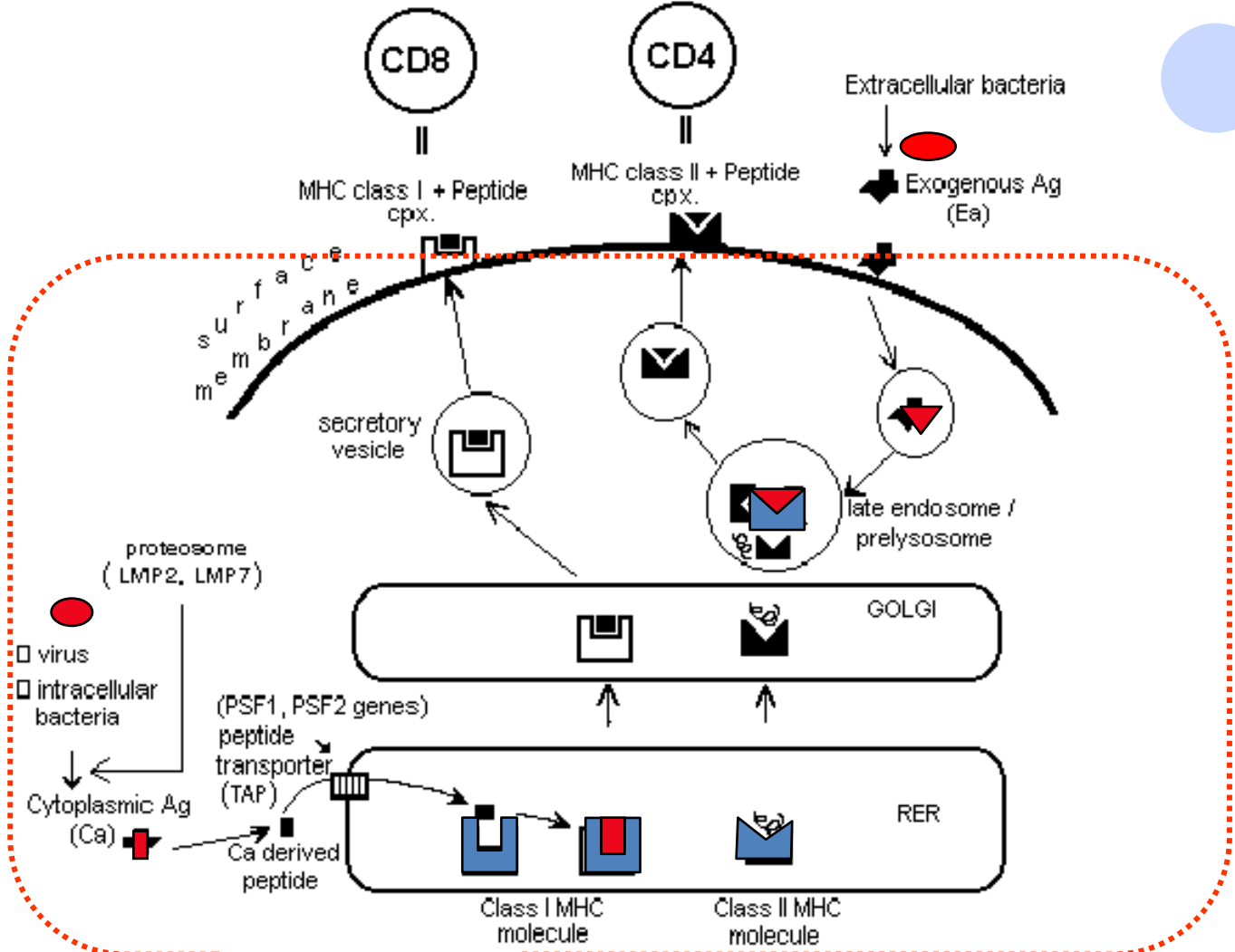


INNATE IMMUNE RESPONSE

ADAPTIVE IMMUNE RESPONSE

endogenous

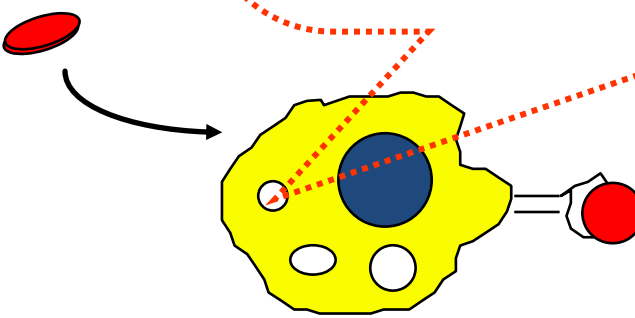
Antigen



exogenous

Antigen processing

Antigen Presenting Cell



# Two signals are required of activation of T cells

- Two signals are required to activate T cells

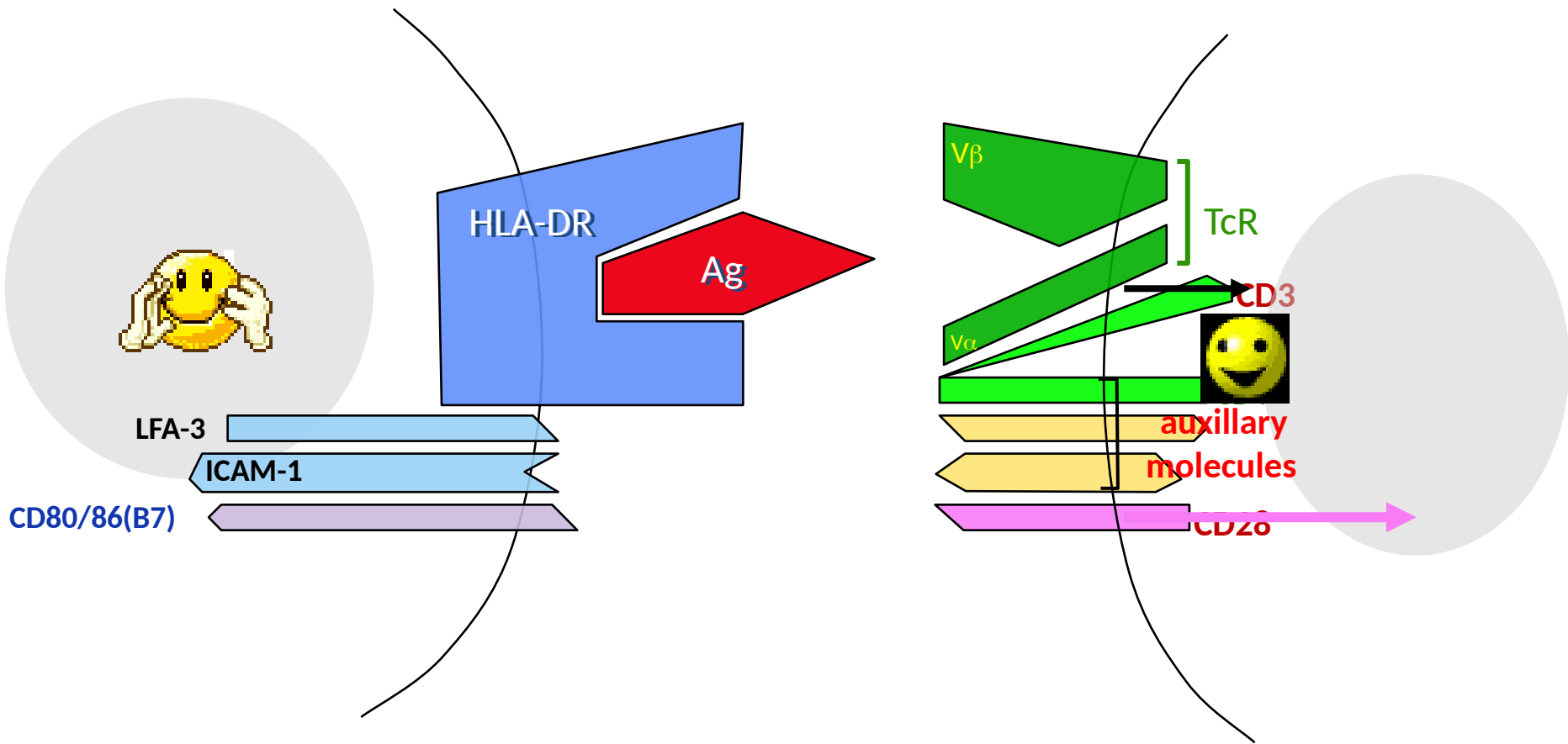
- **First signal**

Class II MHC + antigen – TCR

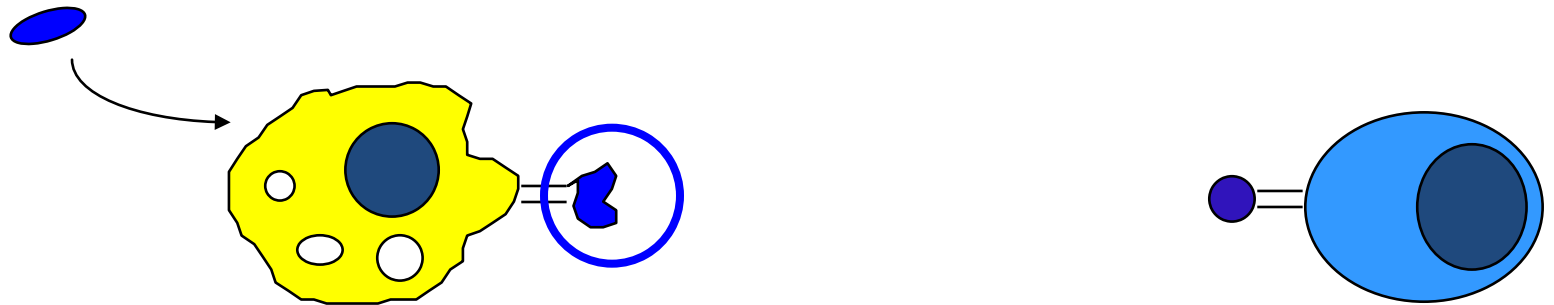
IL-1, LFA-1 with ICAM

- **Second signal (Costimulatory signal)**

B7 on APC interacts with CD28 on lymphocyte



### Trimolecular complex



## **T lymphocytes ("T cells"): CMI**

- **Subsets include:**
  - **CD4+ helper T cells** enhance CMI and production of antibodies by B cells
  - **CD8+ cytotoxic T lymphocytes (CTLs)** that kill virus-infected and tumor cells

**NKT cells, and NK cells** can also eliminate infected cells and abnormal tumor cells

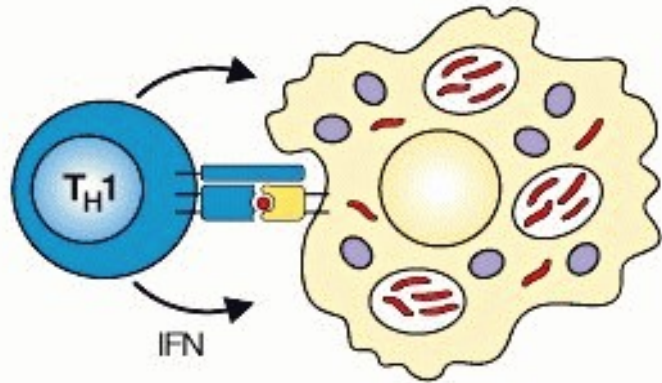
# Out come of T helper cell activation

- **Production of IL-2 and its receptor**
  - IL-2 is also know as T cell growth factor
  - Proliferation of antigen specific T cells
  - Effector and regulatory cells are produced along with “*memory*” cells
  - IL-2 also stimulates CD8 cytotoxic cells
- **Production of Interferons**
  - Enhances anti-microbial activity of macrophages

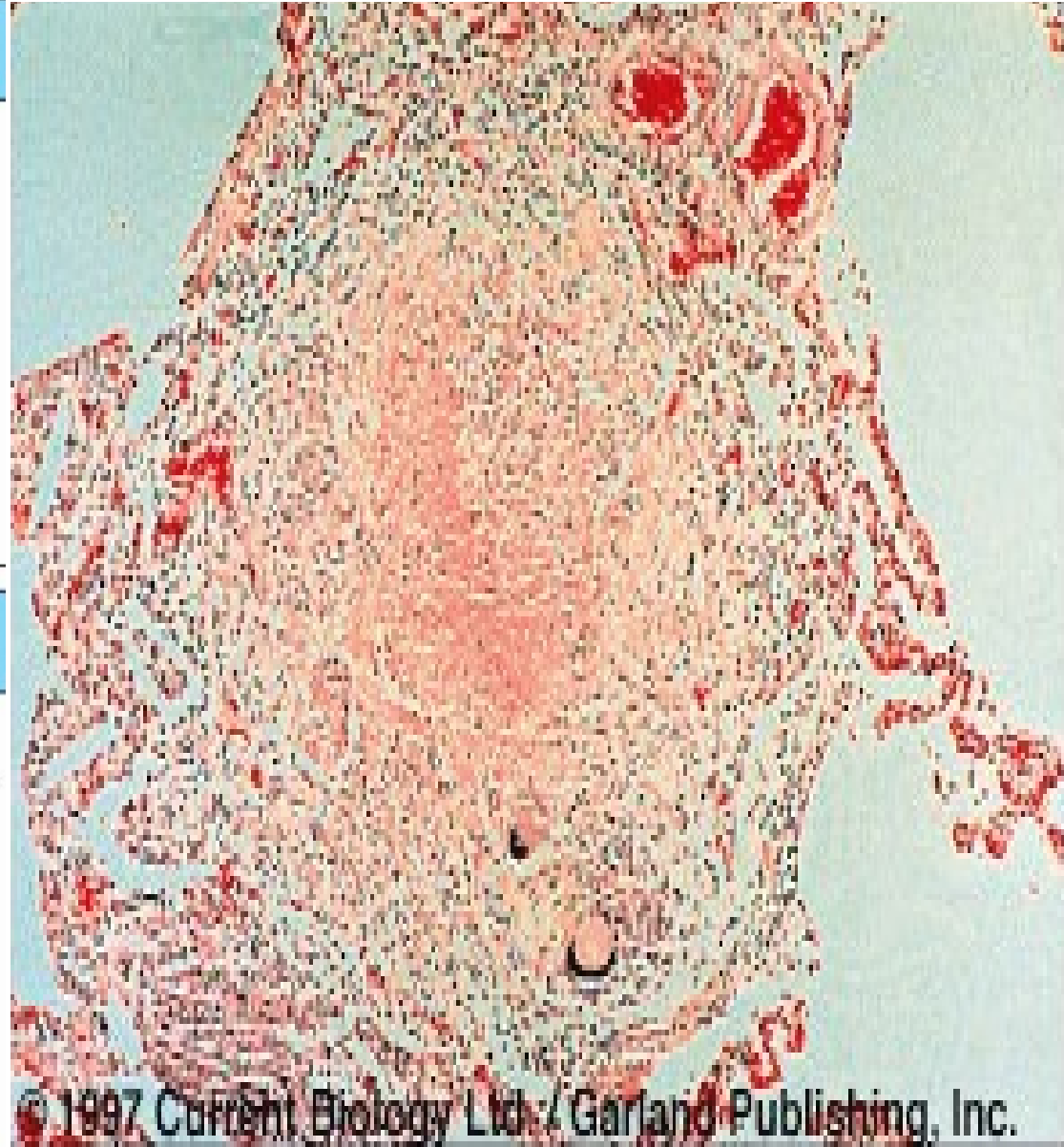
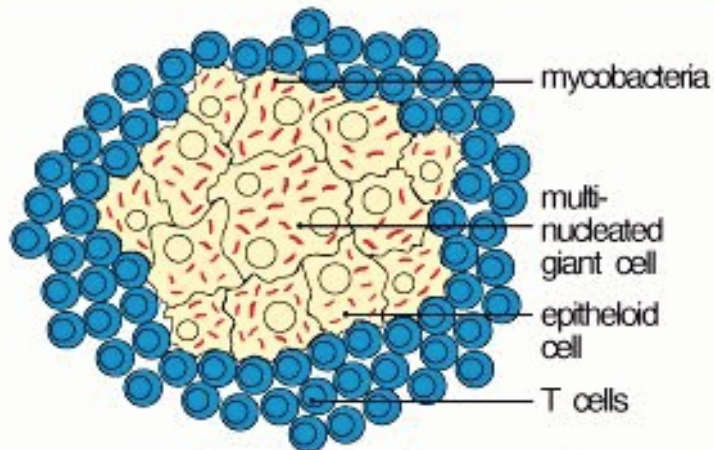


# Granuloma Formation (Chronic Inflammation, e.g., TB)

Partial removal of live *M. tuberculosis*



Granuloma



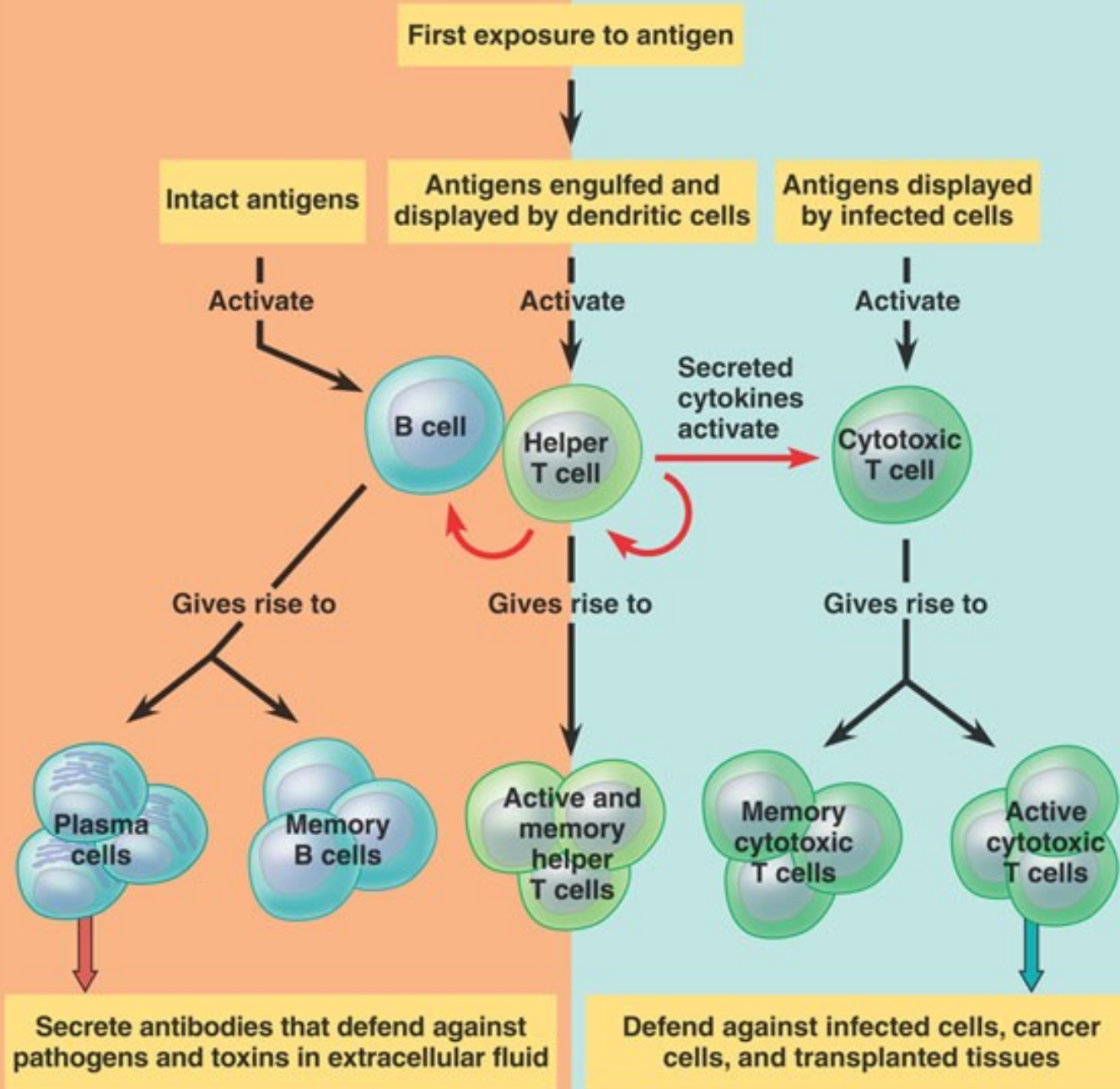
# Out come of T helper cell activation

## Memory T cells

- Respond **rapidly** for many years after initial exposure to antigen
- A large number of memory cells are produced so that the **secondary response** is greater than the primary
- Memory cells **live for many years** and have the capacity to multiply
- They are activated by **smaller amount of antigen**
- They produce greater amounts of interleukins

## Humoral immune response

## Cell-mediated immune response



- **Examples of Cell Mediated Immunity**

1. Delayed type of hypersensitivity (DTH) reaction:

- the tuberculin test**

- Mediated by CD4+ T cells and takes about 72 hours to develop

2. Contact hypersensitivity

- Many people develop rashes on their skin following contact with certain chemicals such as nickel, certain dyes, and poison ivy plant

- The response takes some 24 hours to occur and like DTH, is triggered by CD4+ T cells

Necklace Rash



Contact Dermatitis



# Take Home Message

- Cell mediated adaptive immune response is specific and develops after exposure to a pathogen (antigen)
- Initial antigen exposure results in generation of memory cells for a stronger and a quicker response against future exposures to the same pathogen
- It is usually associated with chronic infections
- Antibodies are not involved