

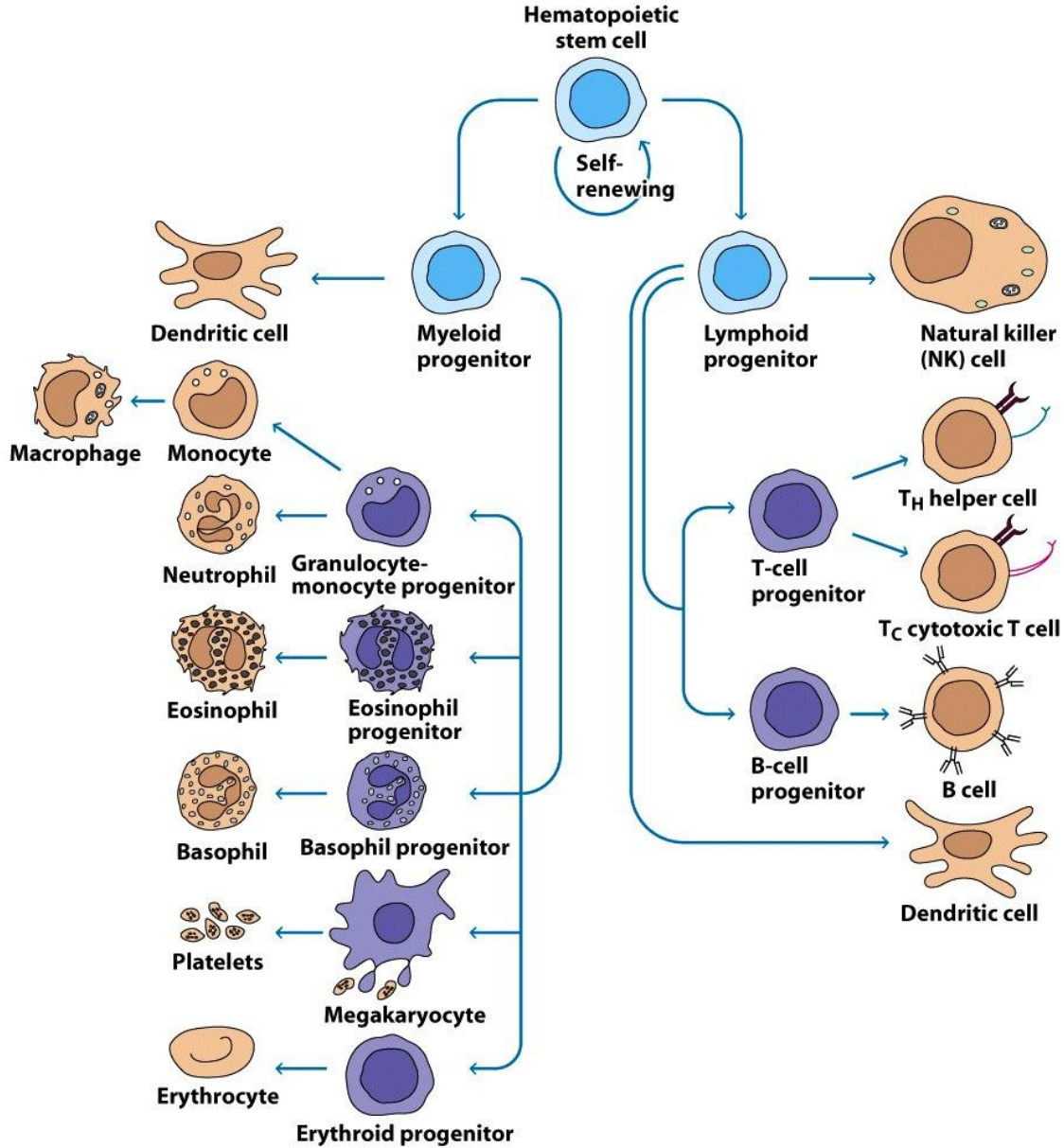
# Adaptive (acquired) immunity

Professor Peter Delves

University College London

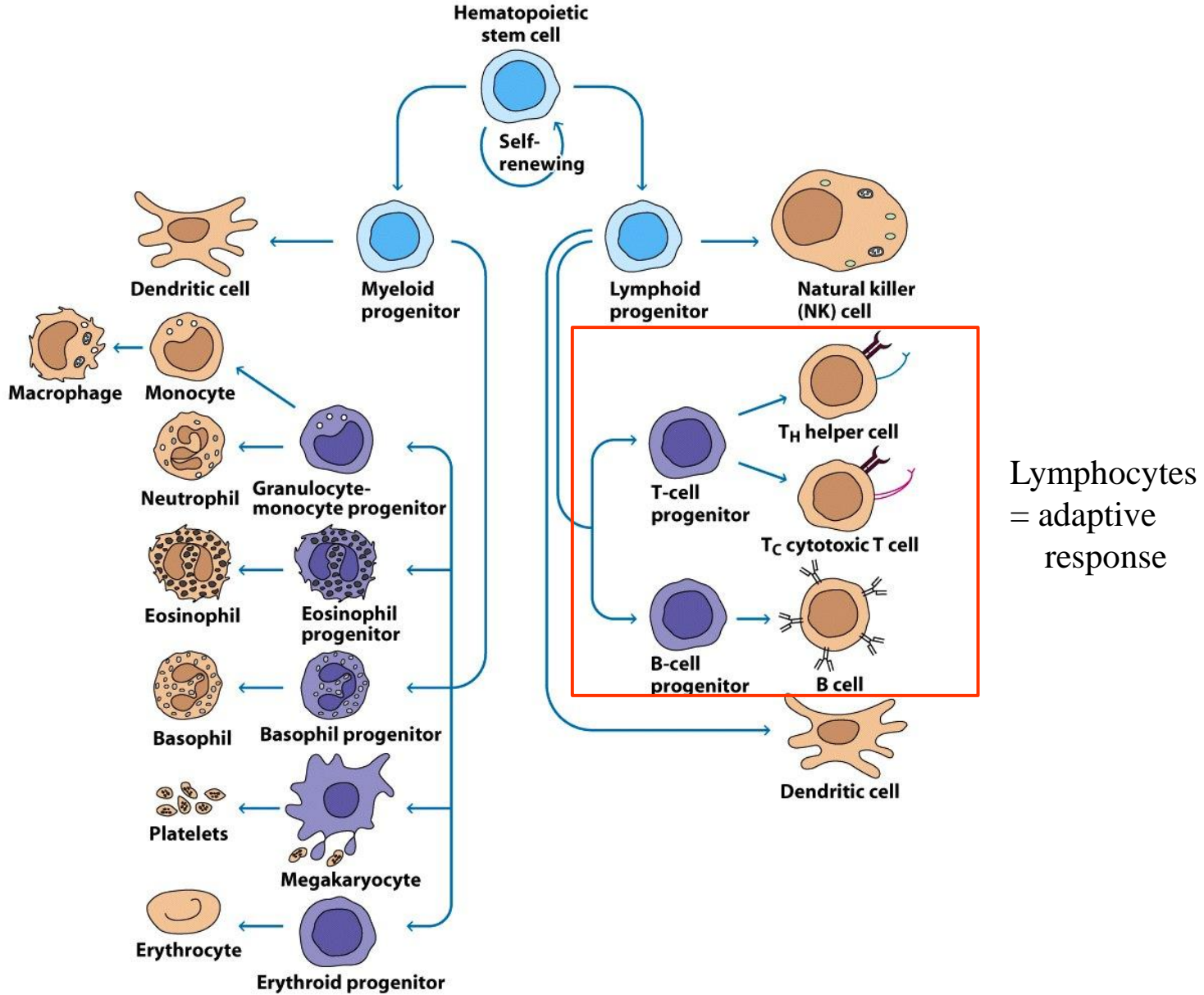
[p.delves@ucl.ac.uk](mailto:p.delves@ucl.ac.uk)

# Haematopoiesis



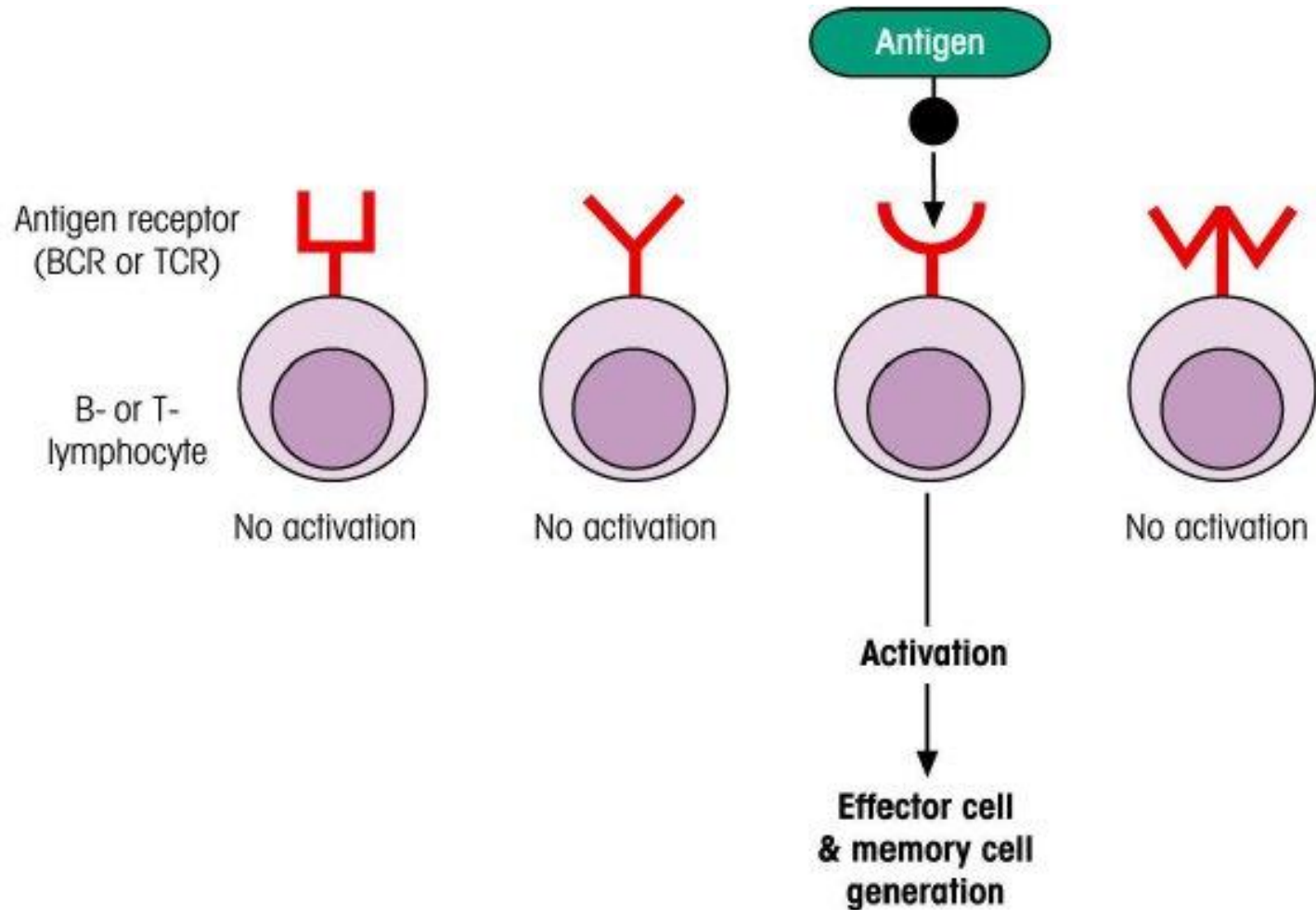
**Figure 2-2**  
 Kuby *IMMUNOLOGY, Sixth Edition*  
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# Haematopoiesis



**Figure 2-2**  
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# Recognition of pathogens by **adaptive cells**, i.e. **lymphocytes**, is **highly antigen-specific**

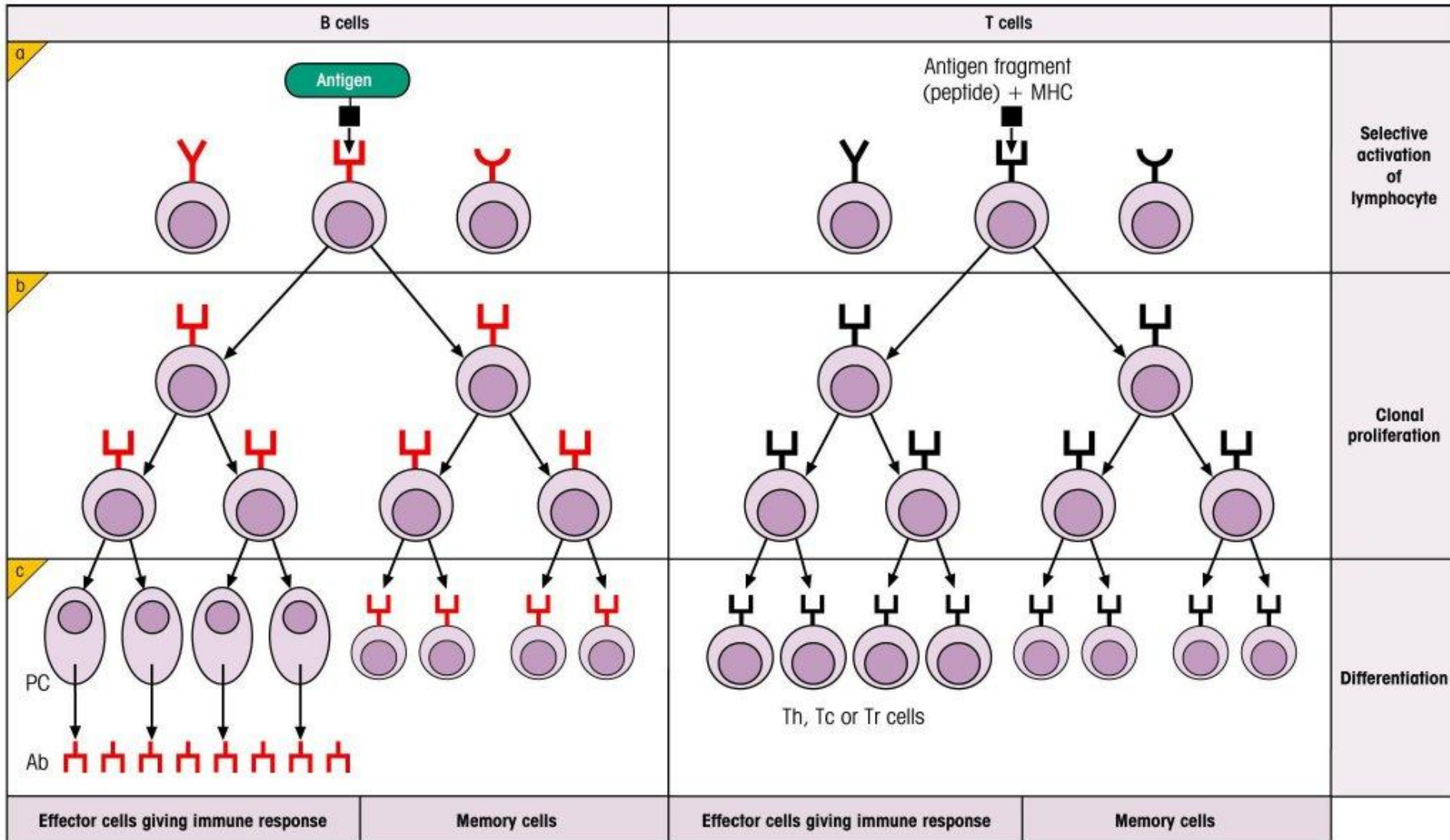


Delves *et al.* *Roitt's Essential Immunology*, 12th ed.

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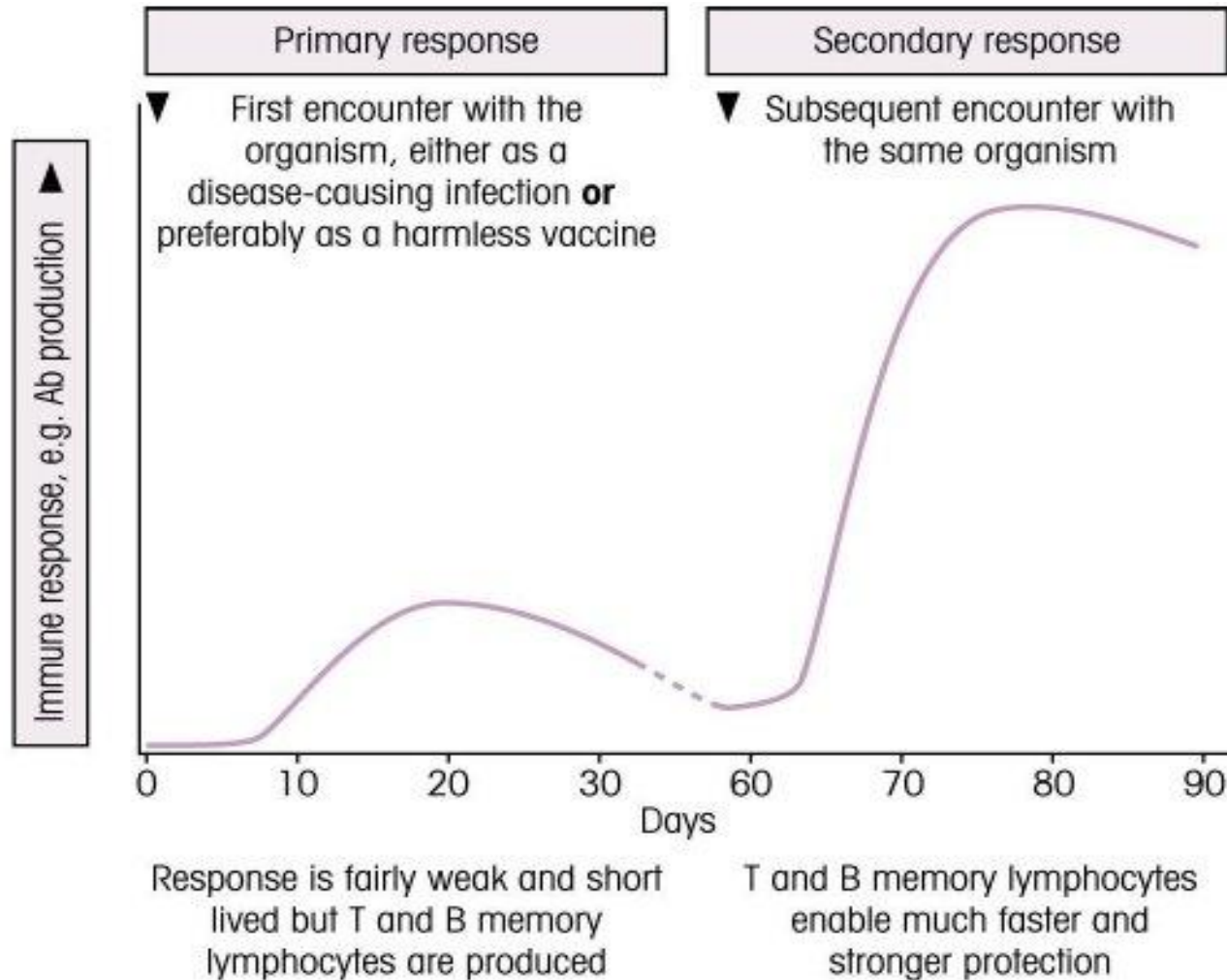
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# Lymphocytes need to proliferate to provide enough specific cells to fight the infection





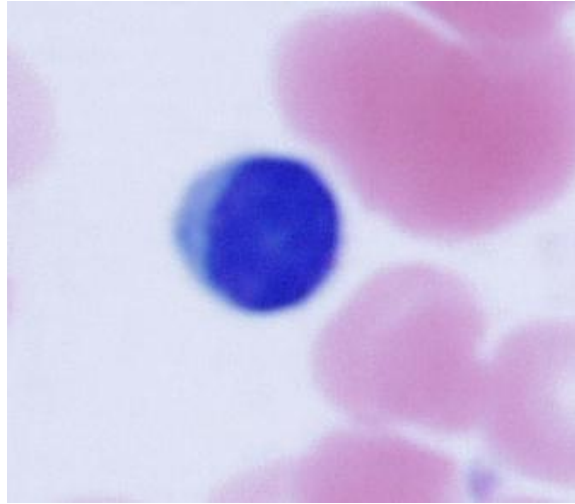
# Adaptive immunity is characterised by primary and secondary immune responses



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# **Adaptive Immunity -Two kinds of lymphocytes: T and B**



Both exhibit:

**1. antigen-specificity**

**2. immunological memory**

**Adaptive immunity**

# B-cells and T-cells

**B cell**

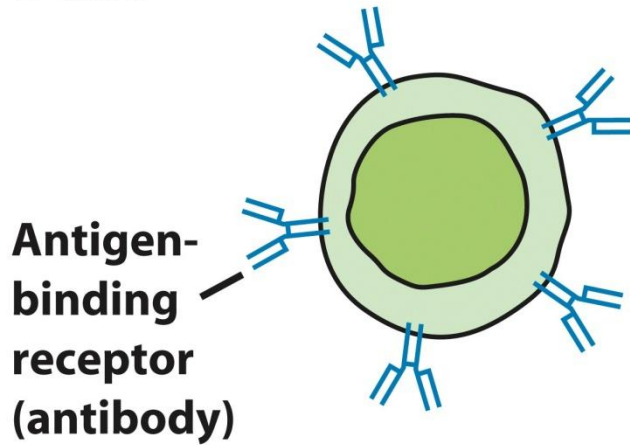


Figure 1-7a  
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**T<sub>H</sub> and Treg cells**

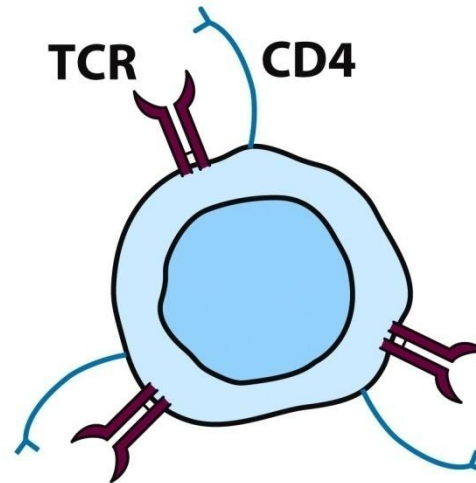


Figure 1-8a  
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**T<sub>C</sub> cell**

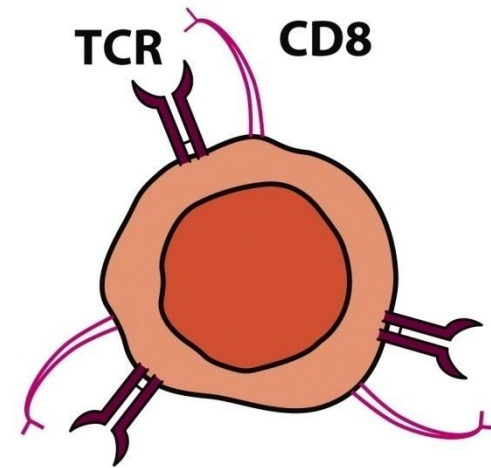


Figure 1-8b  
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# The main differences between T and B lymphocytes

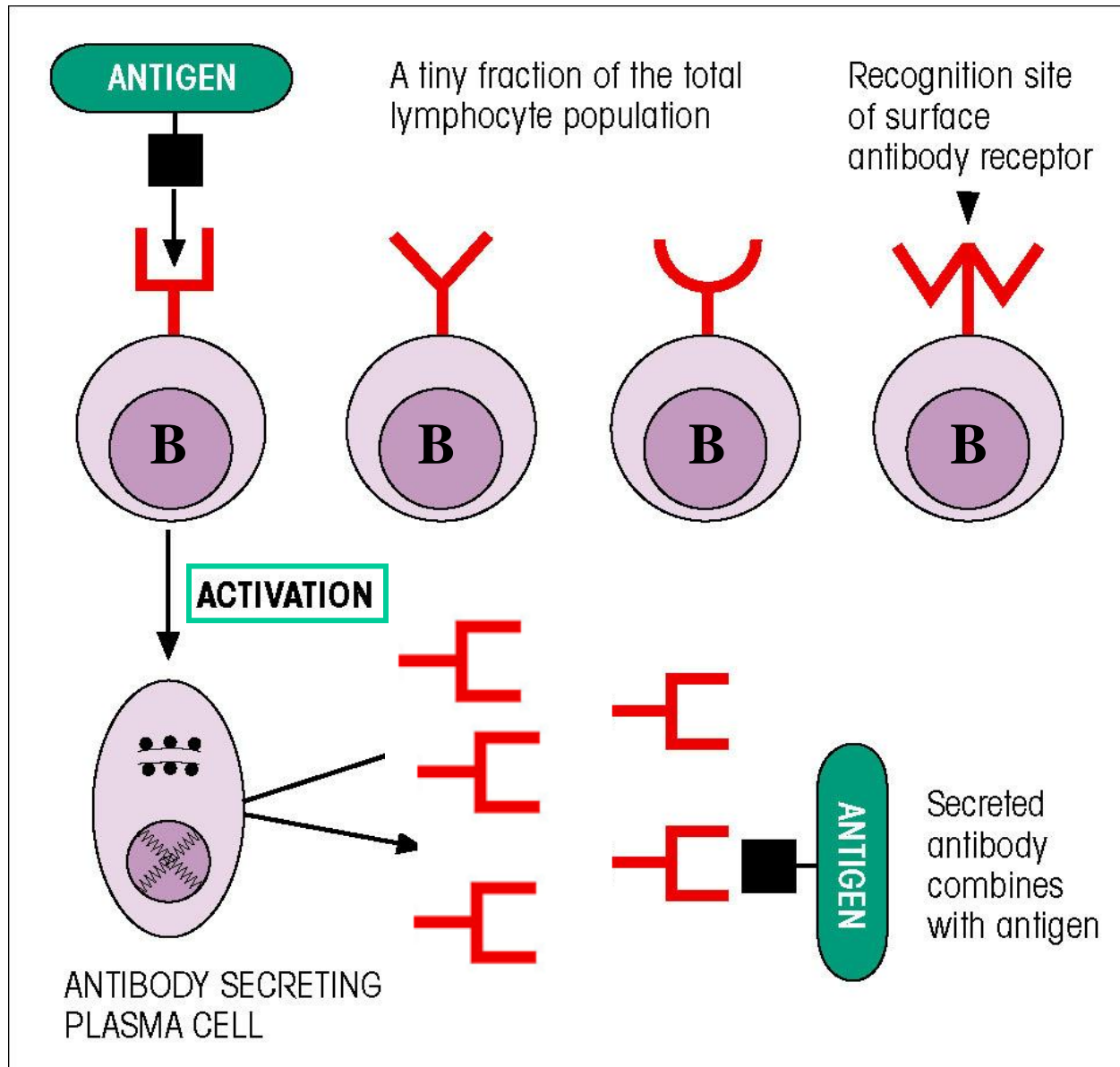
	<b>B cells</b>	<b>T helper cells</b>	<b>T regulatory cells</b>	<b>T cytotoxic cells</b>
<b>Antigen receptor</b>	<b>Antibody (BCR)</b>	<b>T-cell receptor (TCR)</b>	<b>TCR</b>	<b>TCR</b>
<b>Antigen receptor signalling</b>	<b>Ig<math>\alpha</math>/Ig<math>\beta</math></b>	<b>CD3</b>	<b>CD3</b>	<b>CD3</b>
<b>MHC class II (high density)</b>	<b>+</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>CD19</b>	<b>+</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>CD4 or CD8</b>	<b>Neither</b>	<b>CD4 (mostly)</b>	<b>CD4 (mostly)</b>	<b>CD8 (mostly)</b>
<b>Foxp3</b>	<b>-</b>	<b>-</b>	<b>+</b>	<b>-</b>

# Lymphocytes

**B-cells**

T-cells

# B lymphocytes recognise antigen directly and differentiate into antibody-secreting plasma cells



# **Lymphocytes**

B-cells

**T-cells**

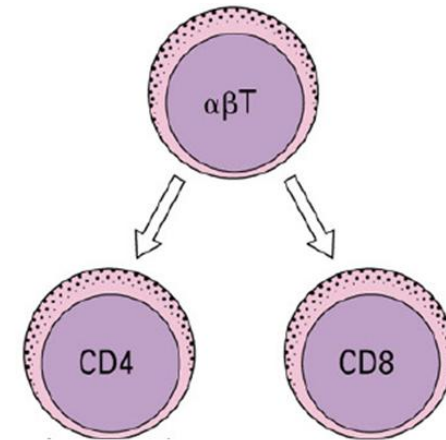
# T-cells recognise antigen using the T-cell receptor (TCR)

2 main types of TCR:

$\gamma\delta$  heterodimer



$\alpha\beta$  heterodimer



Mostly  
Helper T-cells

Mostly  
Cytotoxic T-cells

Unlike antibodies (the BCR) that recognise the three dimensional shape of an antigen, the  $\alpha\beta$  T-cell receptor (**TCR**) **recognises antigen that is:**

a) **Processed** (into peptides, by proteases)

then:

b) **Presented** (by cell surface MHC molecules)

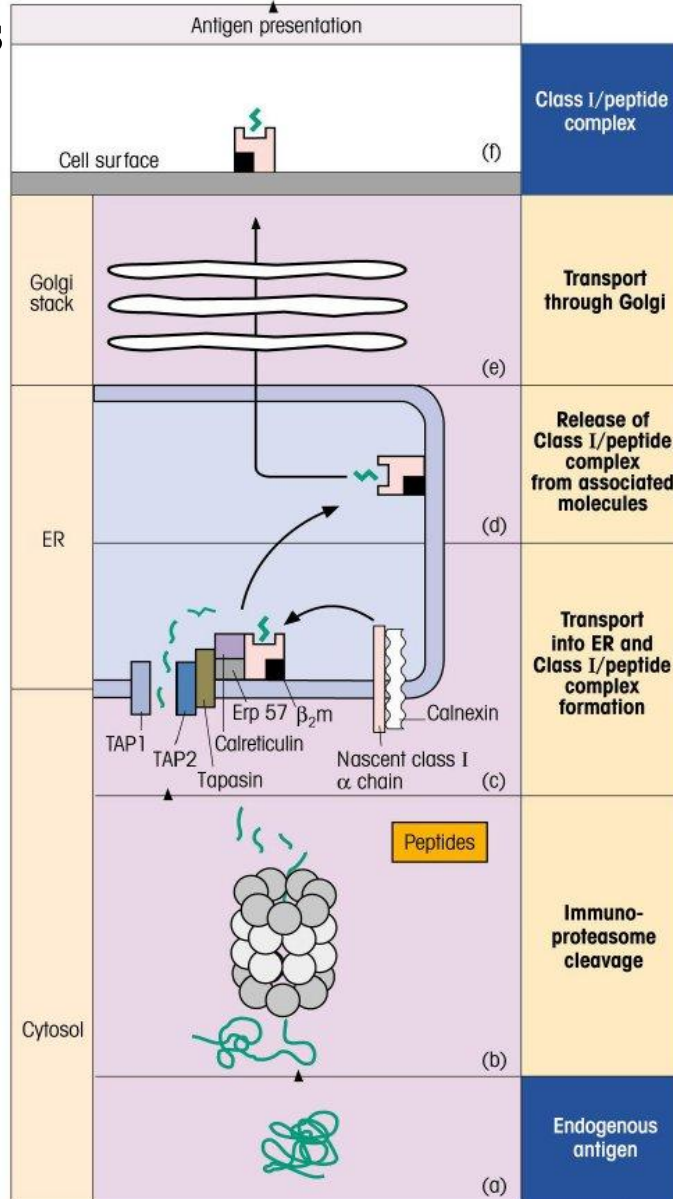


## Two pathways of antigen processing

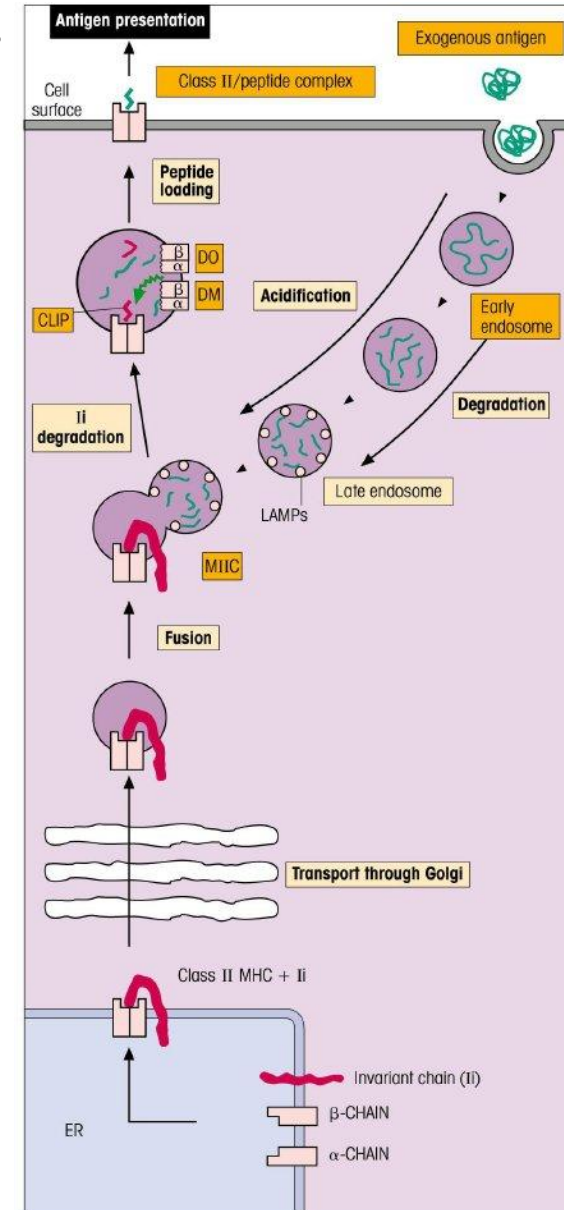
- **Endogenous:** produces peptides **8-9** amino acids long for presentation by **MHC class I**
- **Exogenous:** produces peptides **~15** amino acids long for presentation by **MHC class II**

# Processing pathways for presenting antigen to T cells

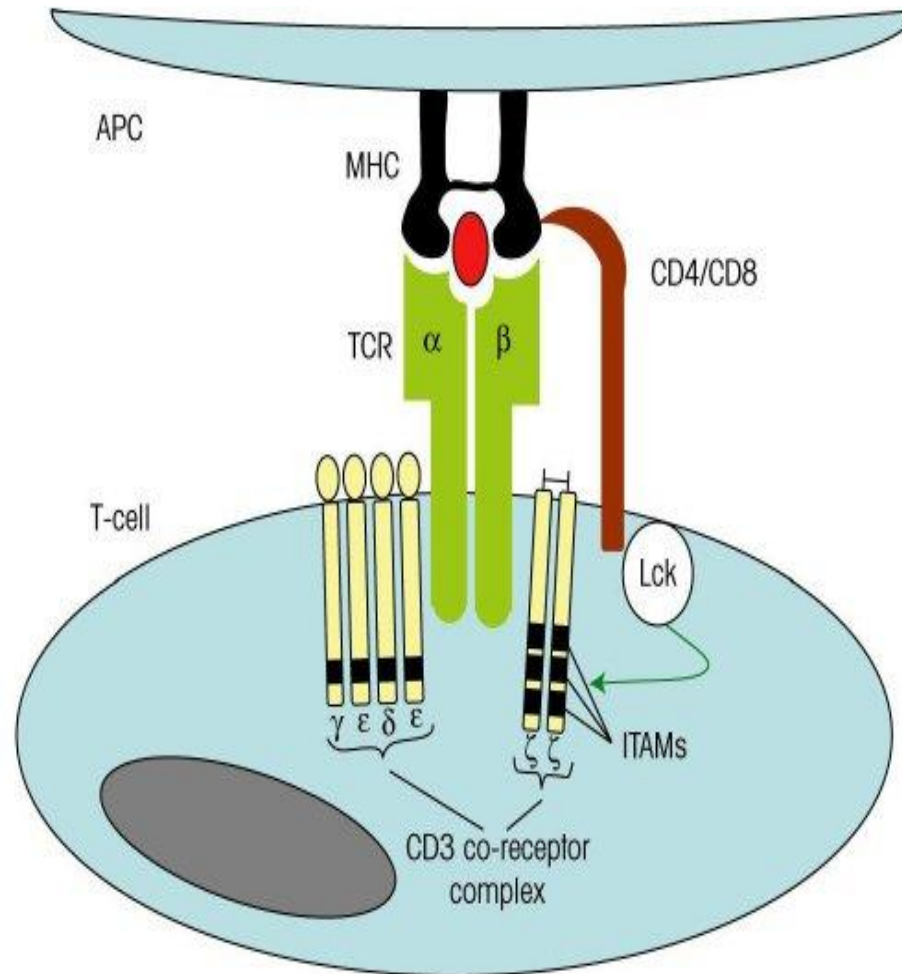
## Endogenous



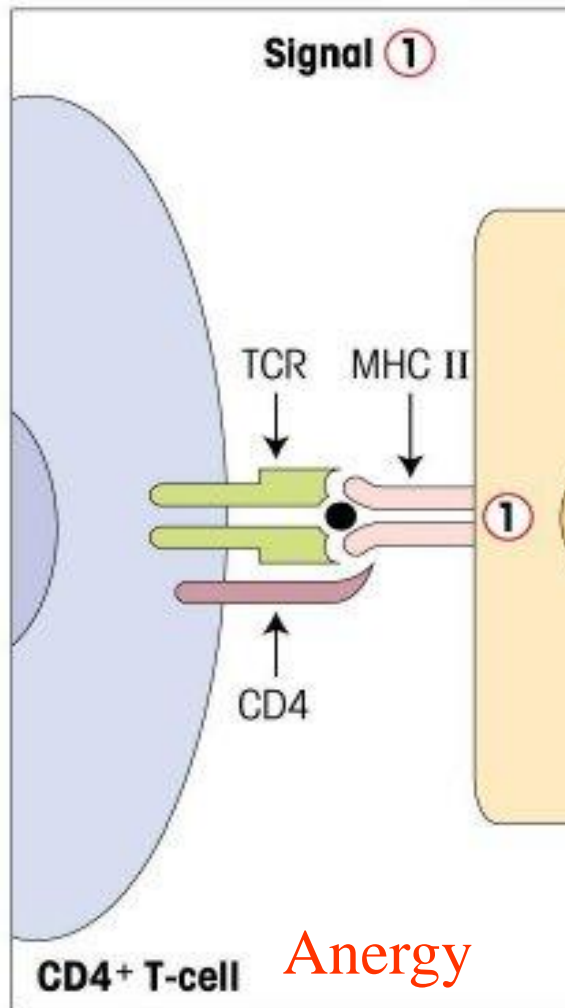
## Exogenous



# $\alpha\beta$ TCR recognises processed antigen presented by MHC

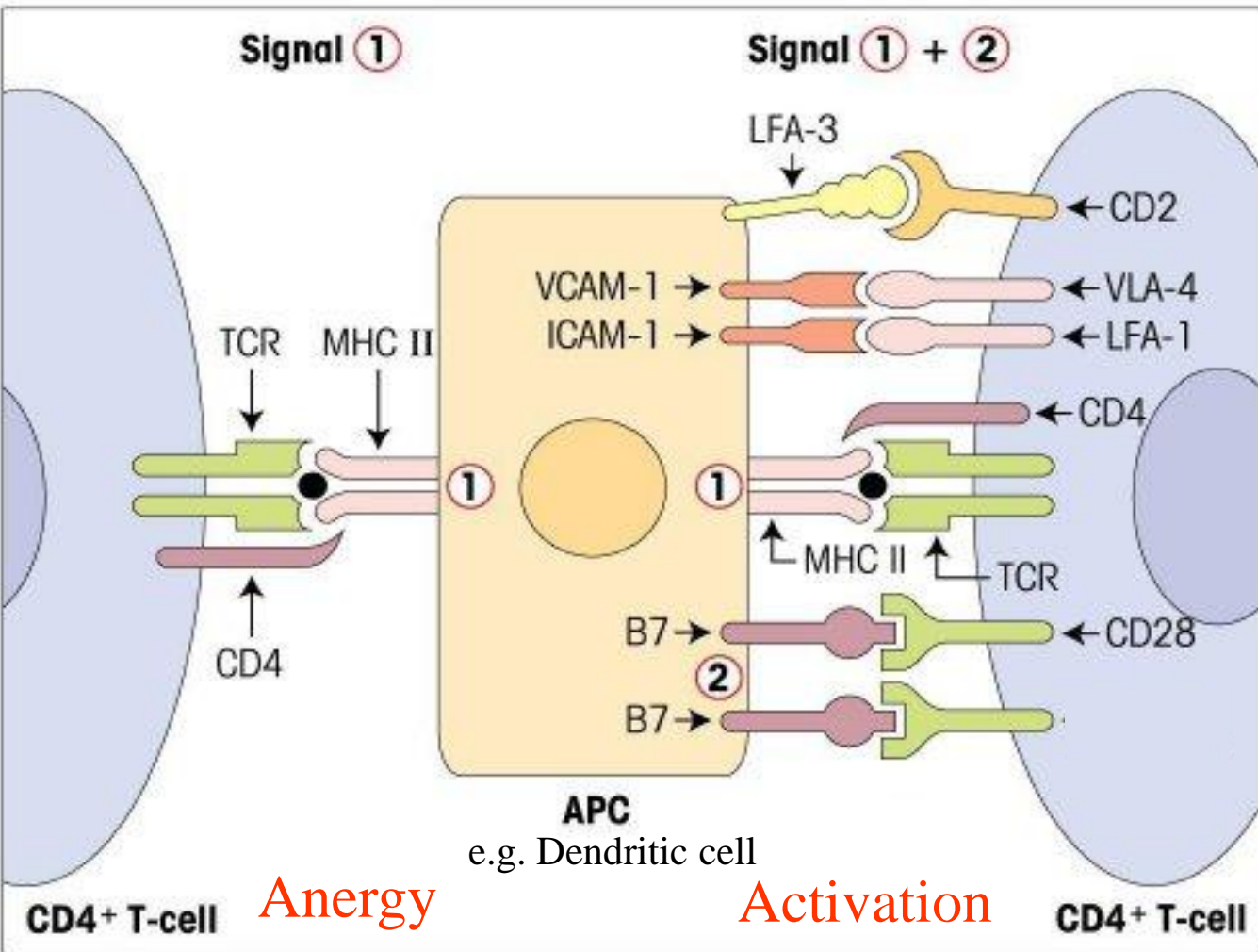


# Activation of the T-cell requires costimulation



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# Activation of the T-cell requires costimulation



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# Functional activity of T-cells

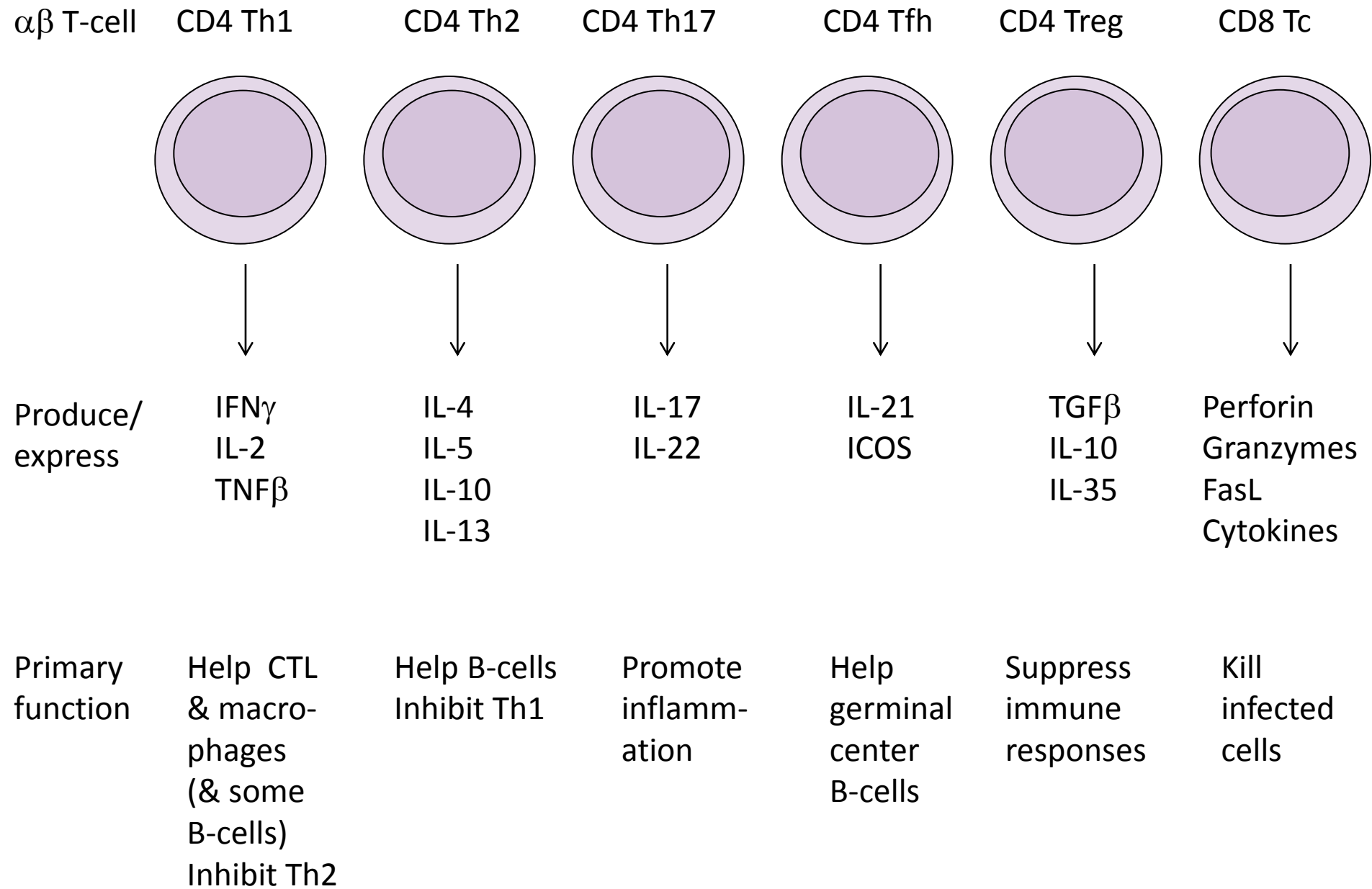
Proliferate

Mediate effector functions

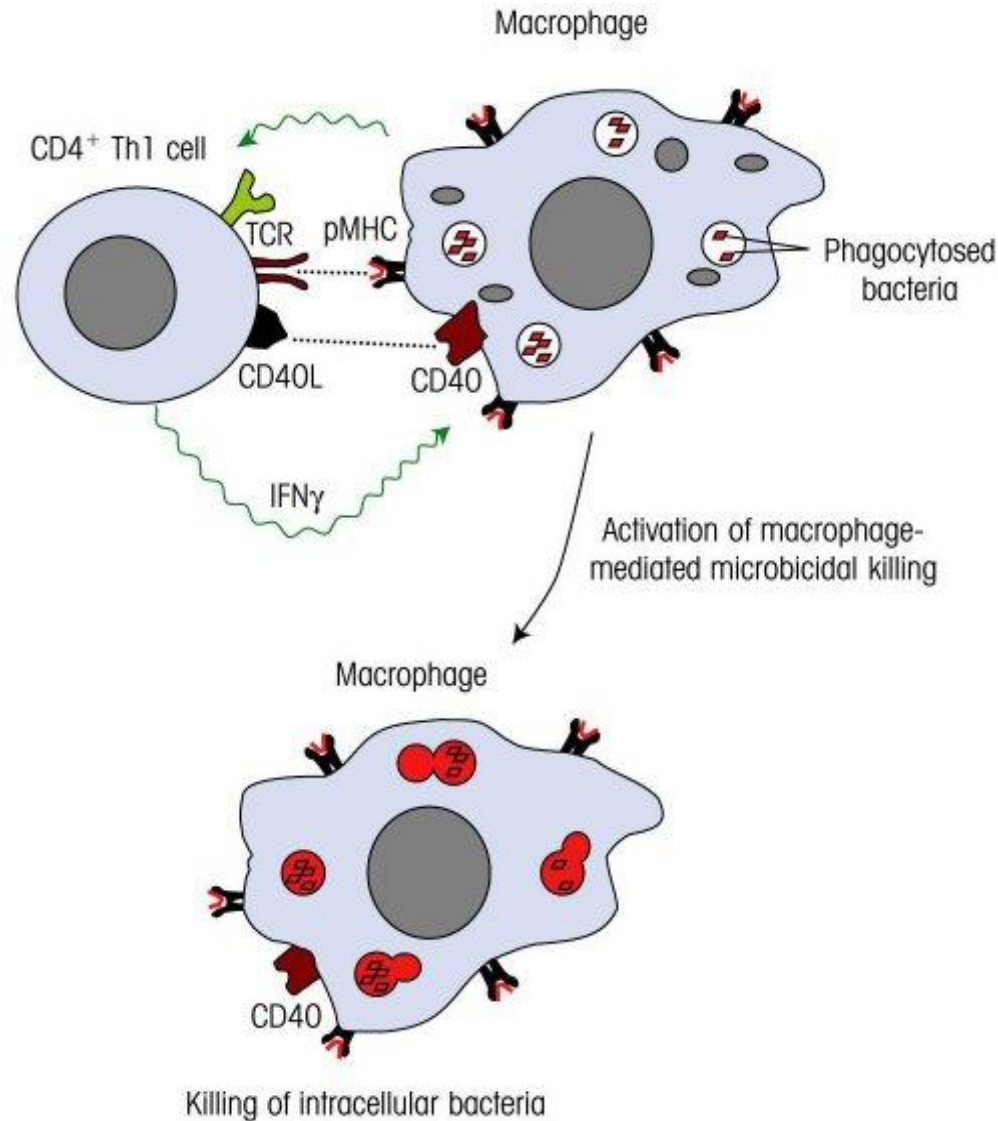
Form memory cells



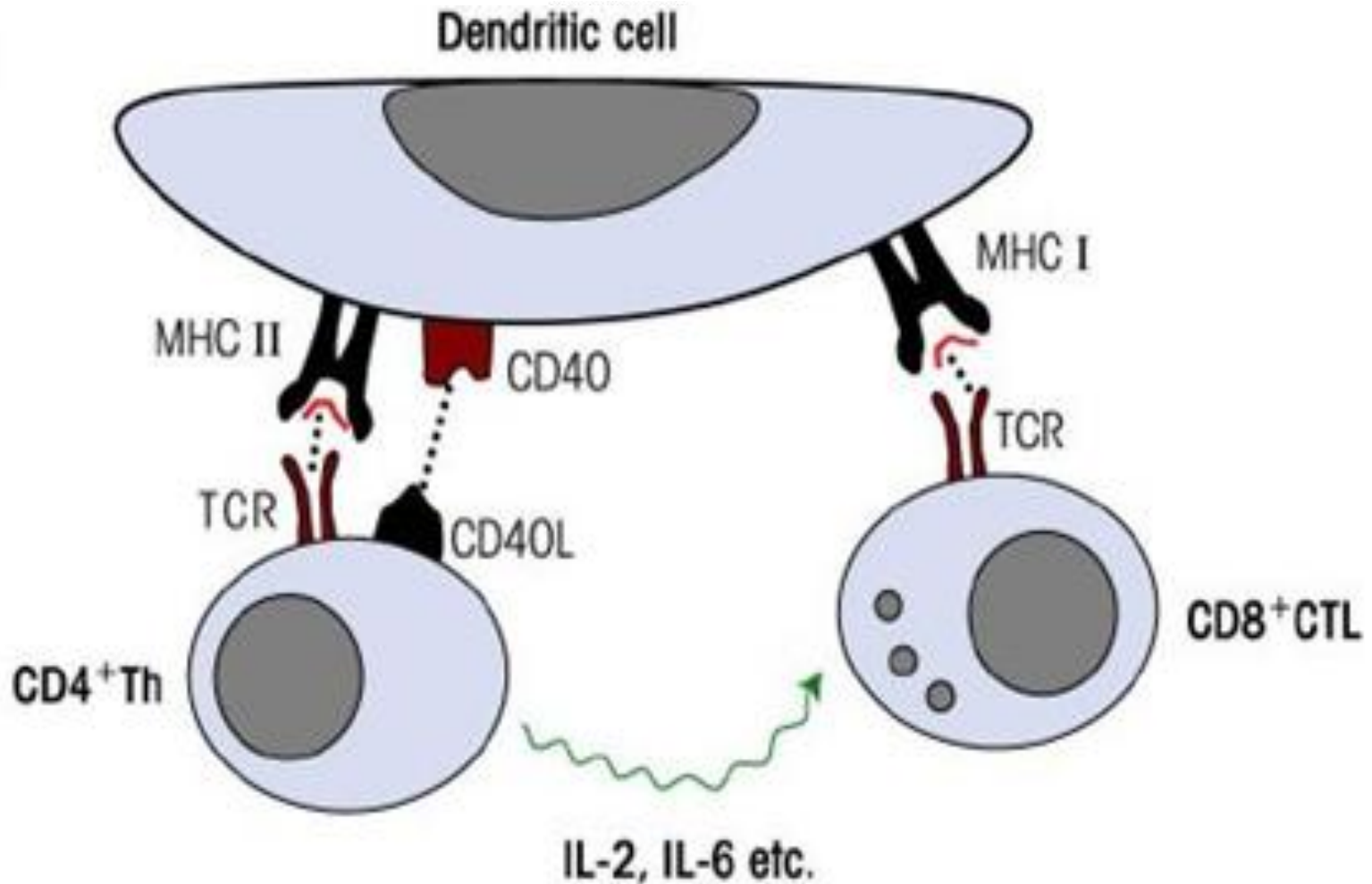
# Different types of T-cell effector function



# T helper cell activation of macrophages

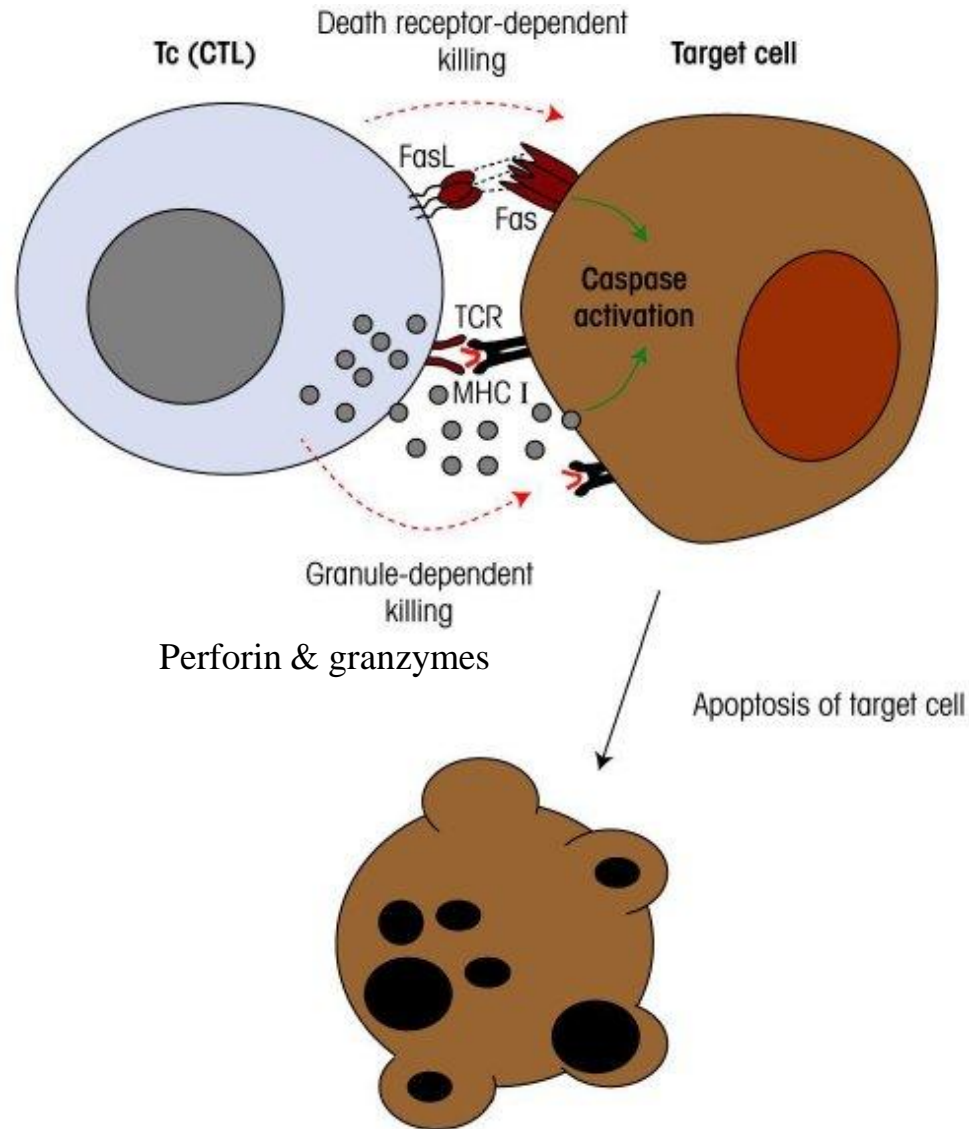


# T helper cell activation of cytotoxic T-cells

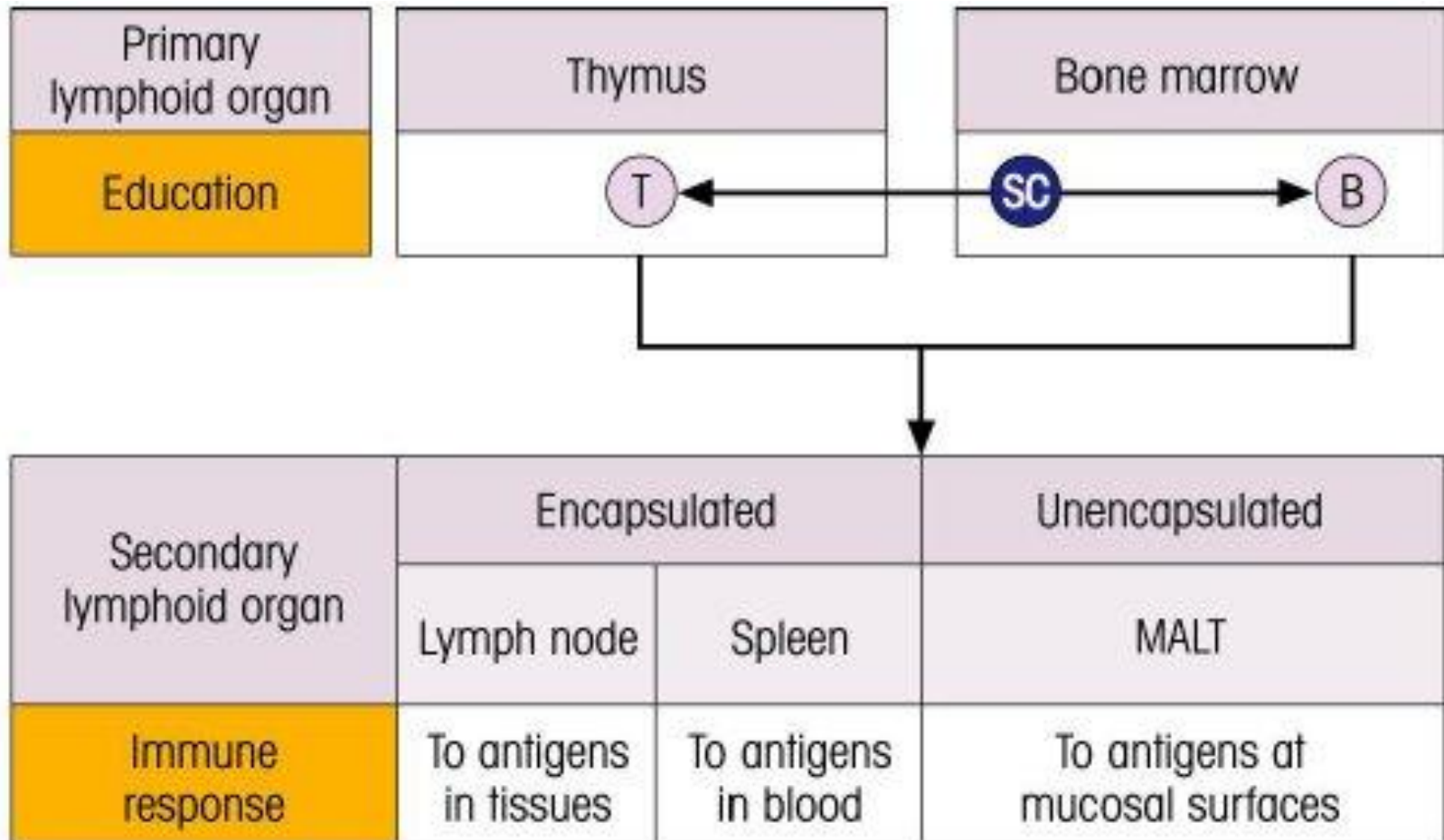


# Cytotoxic T-lymphocytes (CTL)

# Killing by cytotoxic T-cells



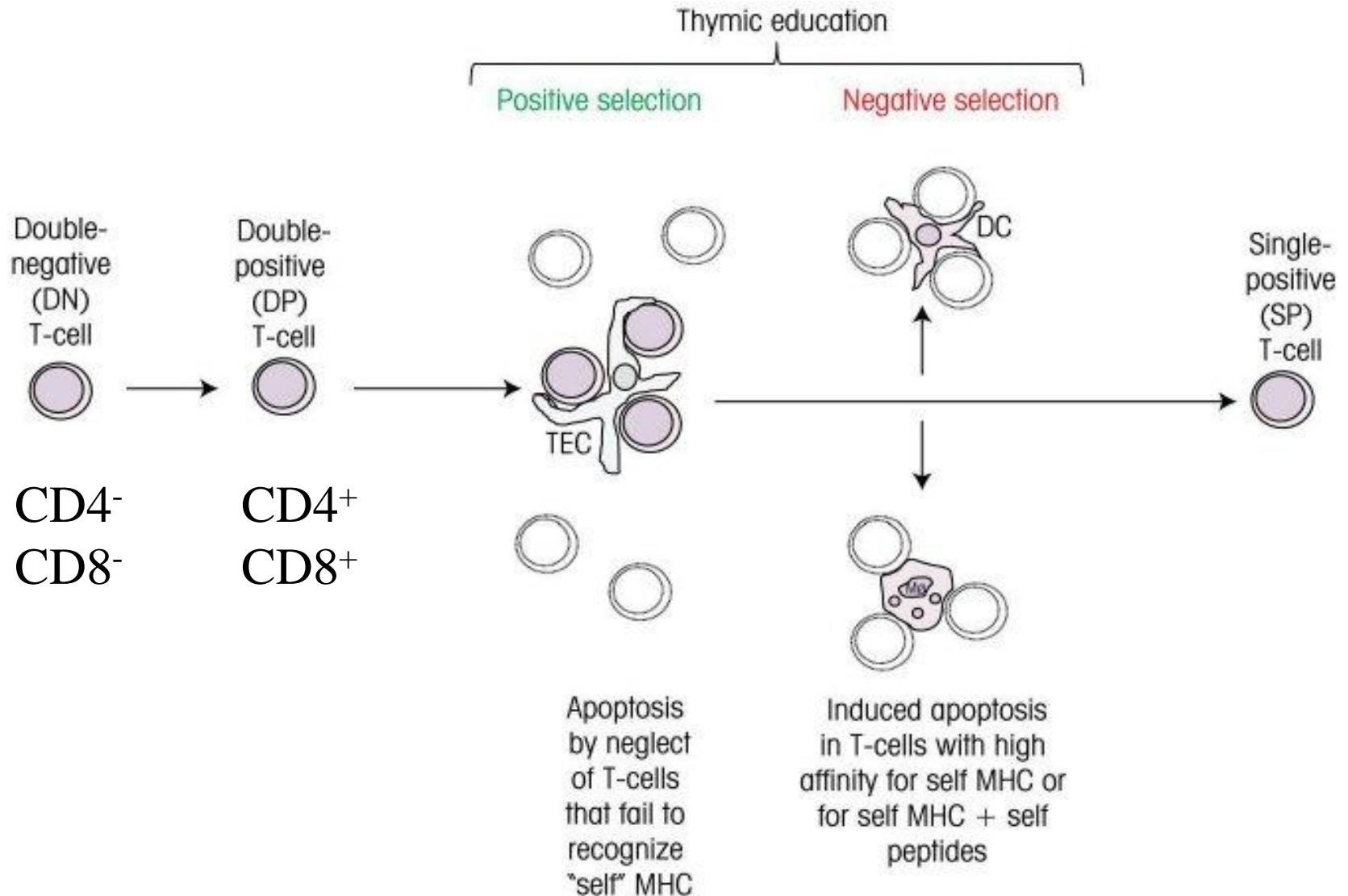
# Lymphocyte development



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# T-cell development in the thymus

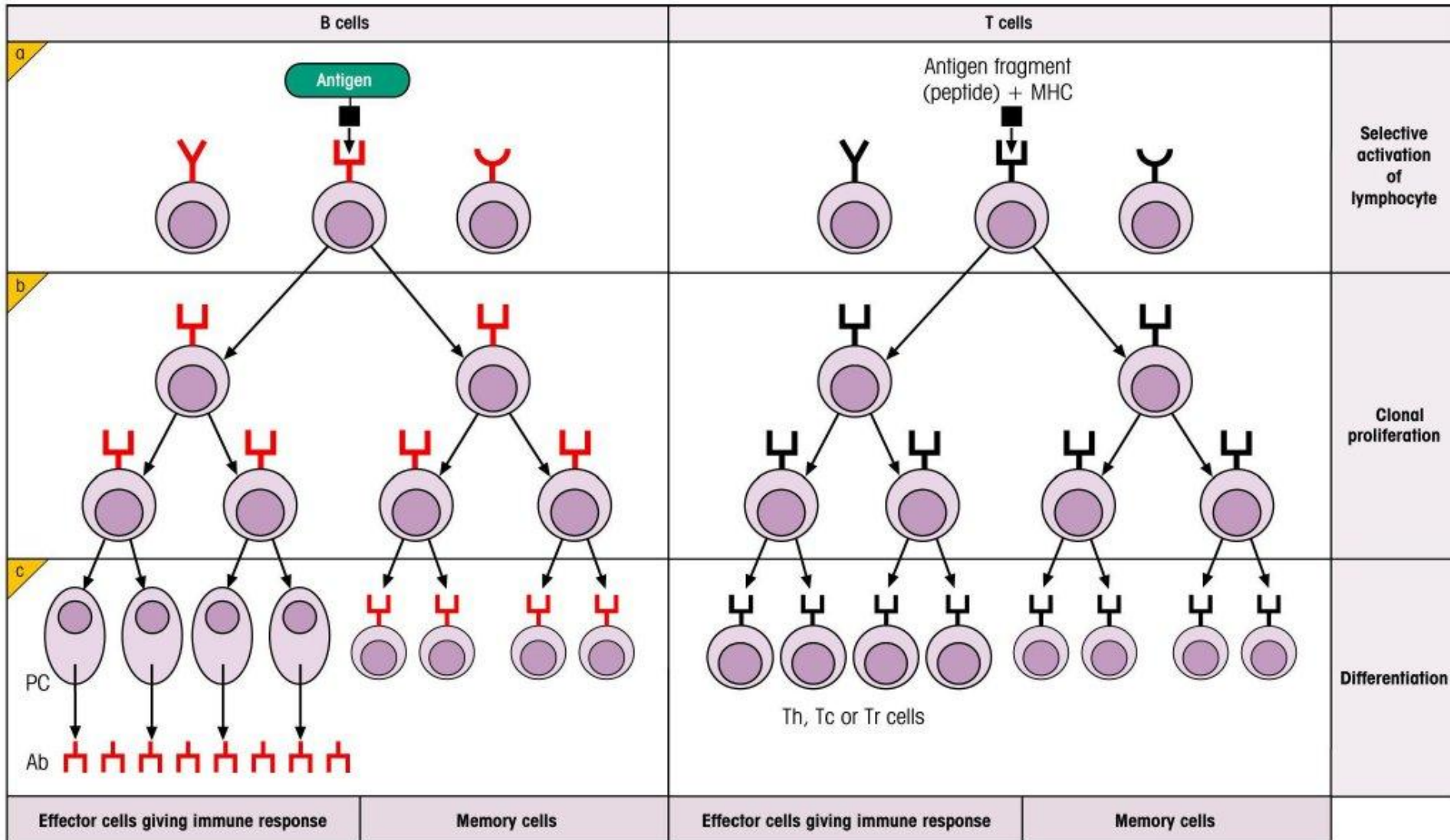


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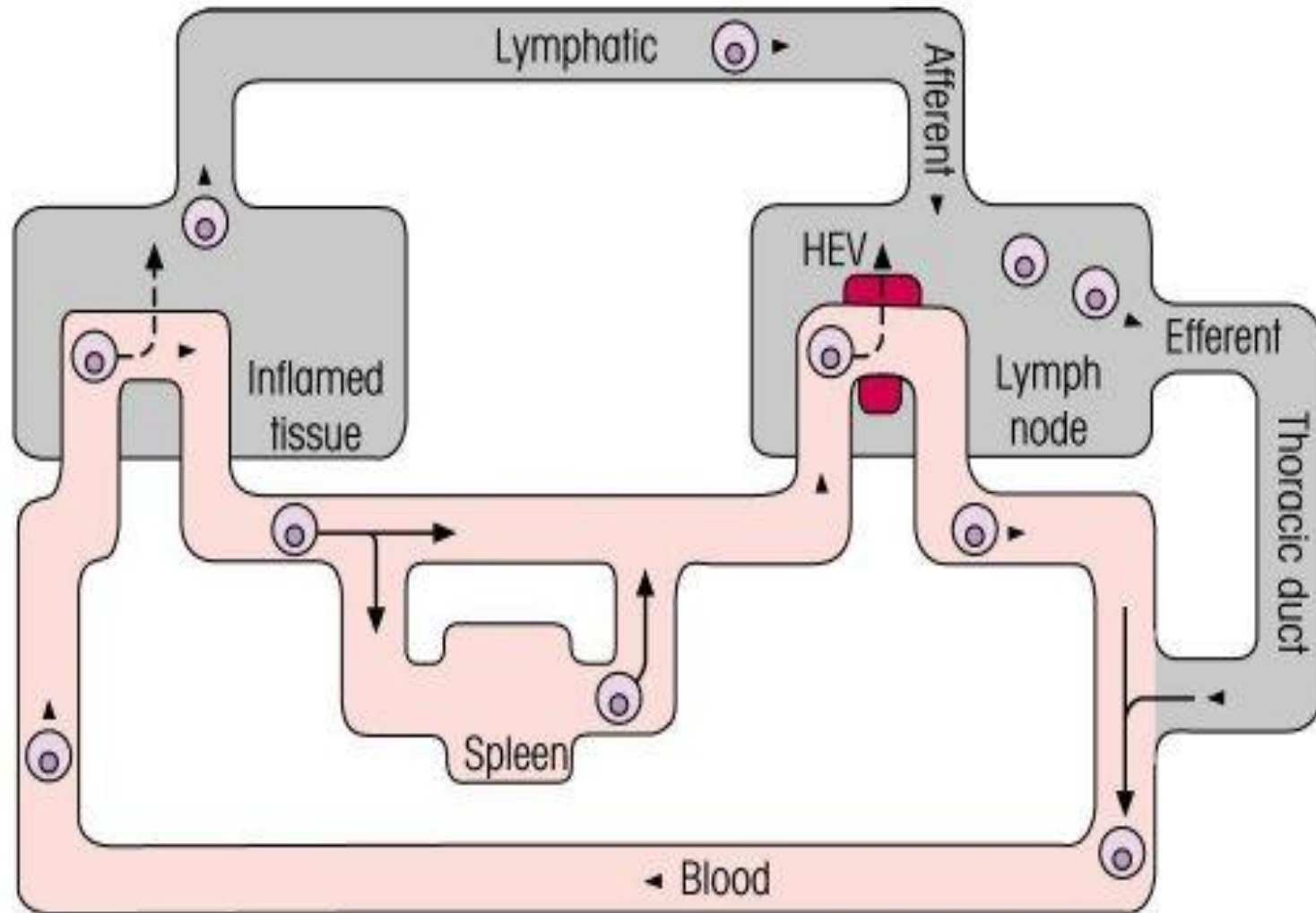
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# Lymphocytes need to proliferate to provide enough specific cells to fight the infection



# Lymphocytes also need to circulate around the body



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# Role of dendritic cells in adaptive immunity

Interdigitating dendritic cells

Present antigen to T cells

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Follicular dendritic cells

Present antigen to B cells

Interdigitating dendritic cells

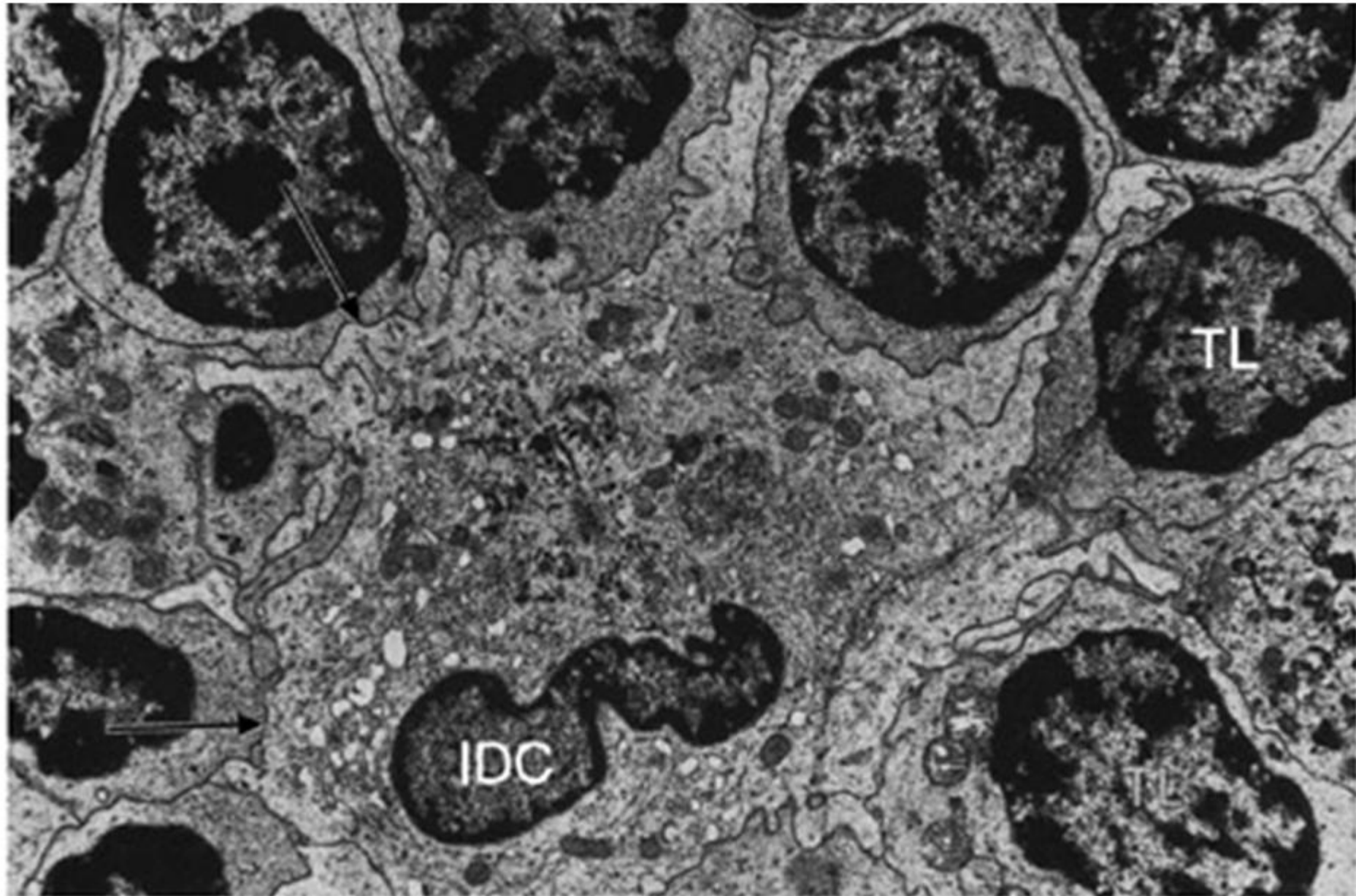
‘dendritic cells’



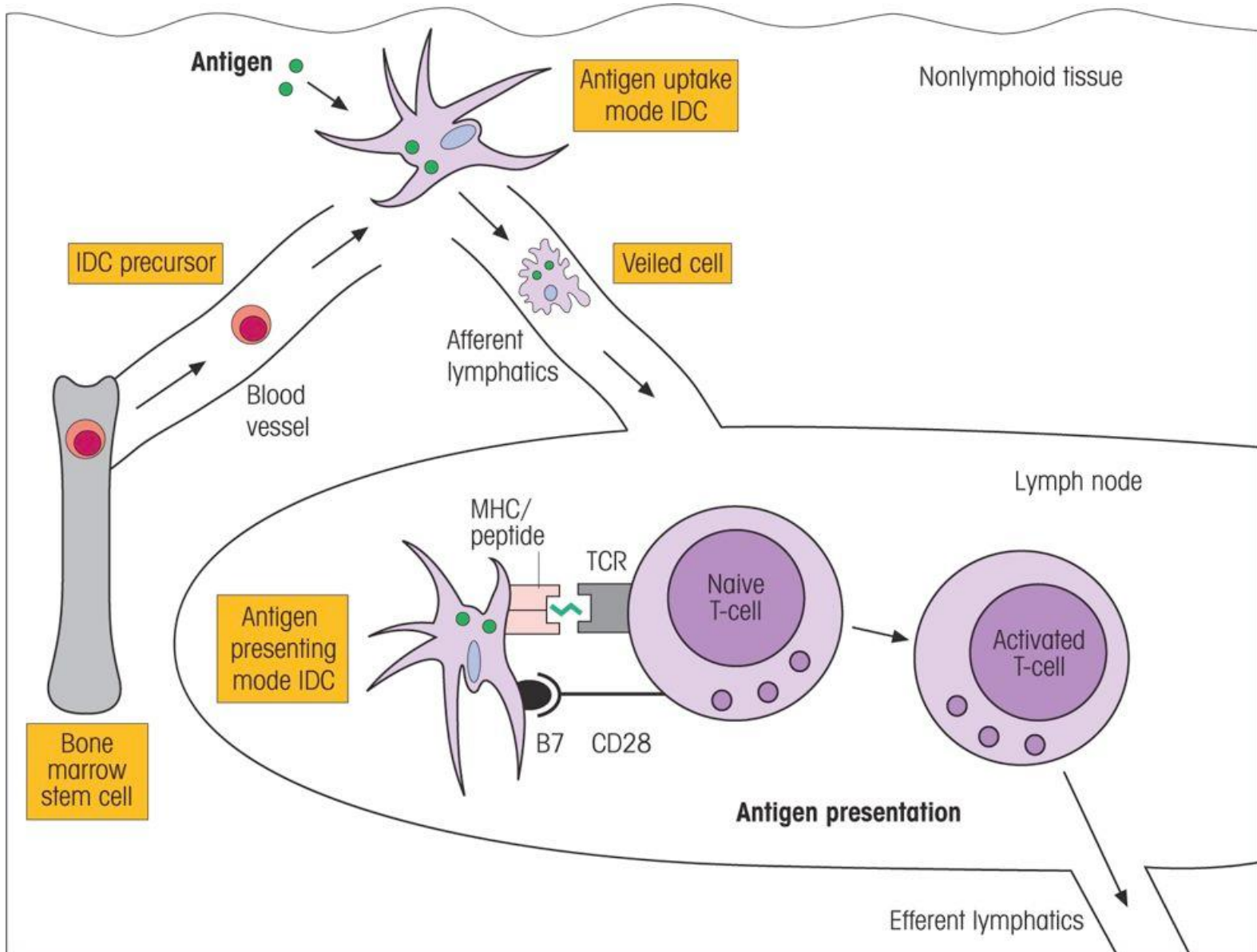
## Interdigitating dendritic cells

- MHC class II<sup>+</sup>
- CD80/CD86<sup>+</sup> (B7.1/B7.2)
- Can activate naive T-cells

**Interdigitating dendritic cell (IDC) surrounded by  
T lymphocytes (TL) in a lymph node**



# Migration and maturation of interdigitating dendritic cells (IDCs)



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# Follicular dendritic cells

# Follicular dendritic cells

- MHC class II negative
- Complement receptor<sup>+</sup>
- Fc $\gamma$ R<sup>+</sup>
- Present antigen to B-cells

# Comparison of IDC and FDC

## IDC

## FDC

Developmental  
origin

Haematopoietic stem cells (HSC)

Unknown (not HSC)

Location

Widespread

Germinal centres of  
secondary lymphoid organs

MHC class II

+

-

CD80 & CD86

+

-

Endocytose/  
(phagocytose) antigen

+ (+/-)

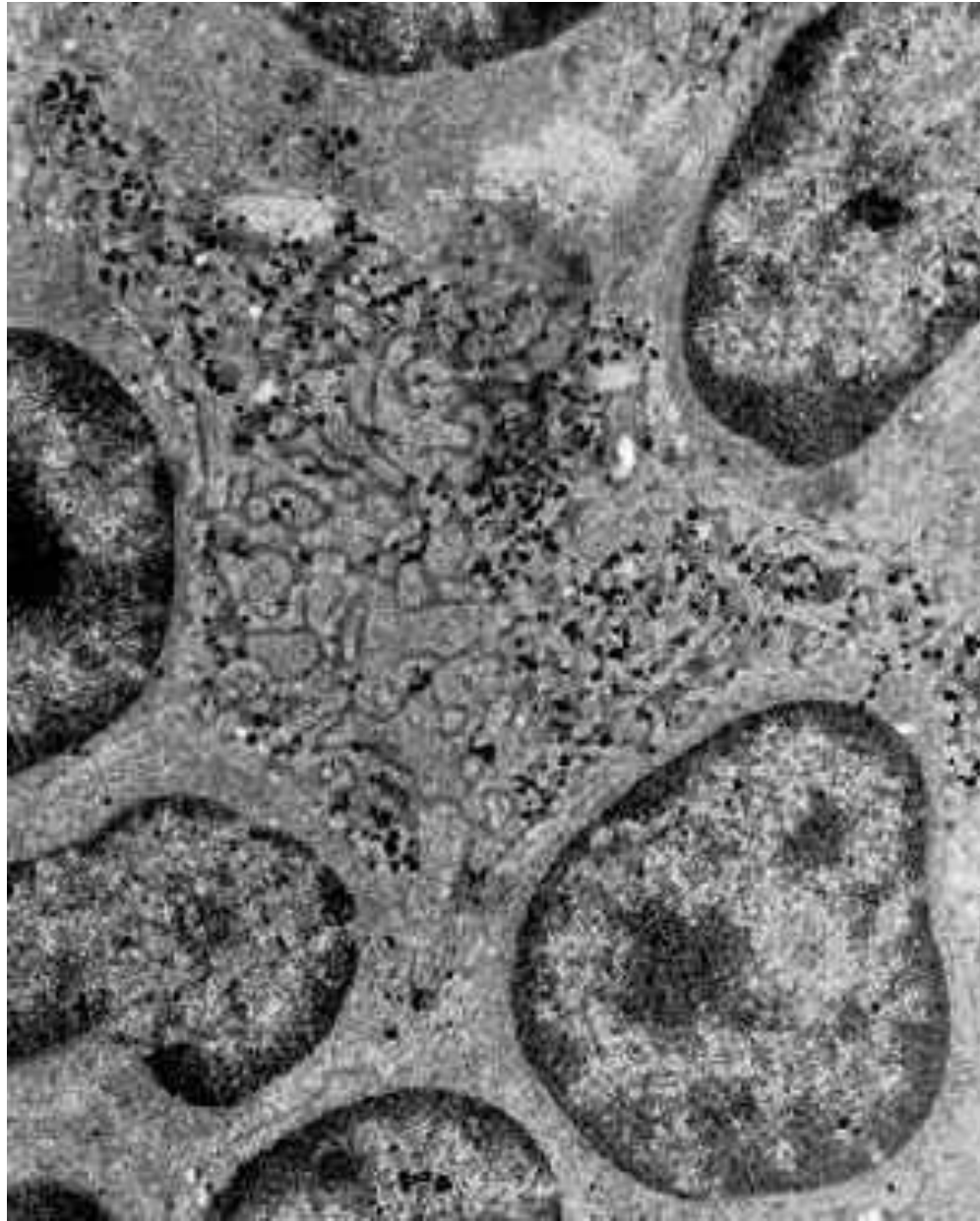
-

Antigen presentation

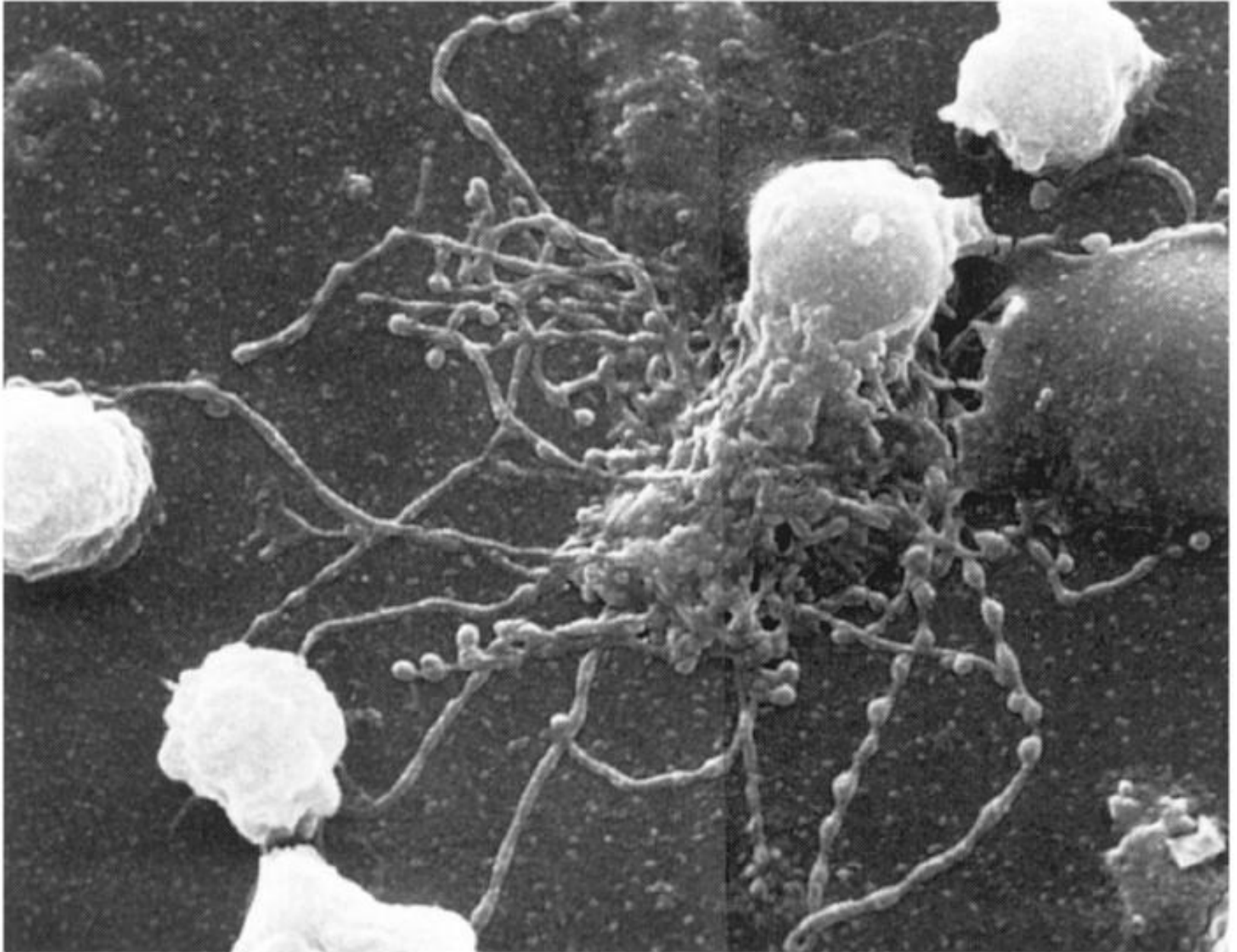
Processed antigen  
to T-cells

Native antigen  
to B-cells

**Follicular dendritic cell (FDC) surrounded by B lymphocytes in a lymph node germinal centre**



# Follicular dendritic cell (FDC)





# Follicular dendritic cell (FDC)

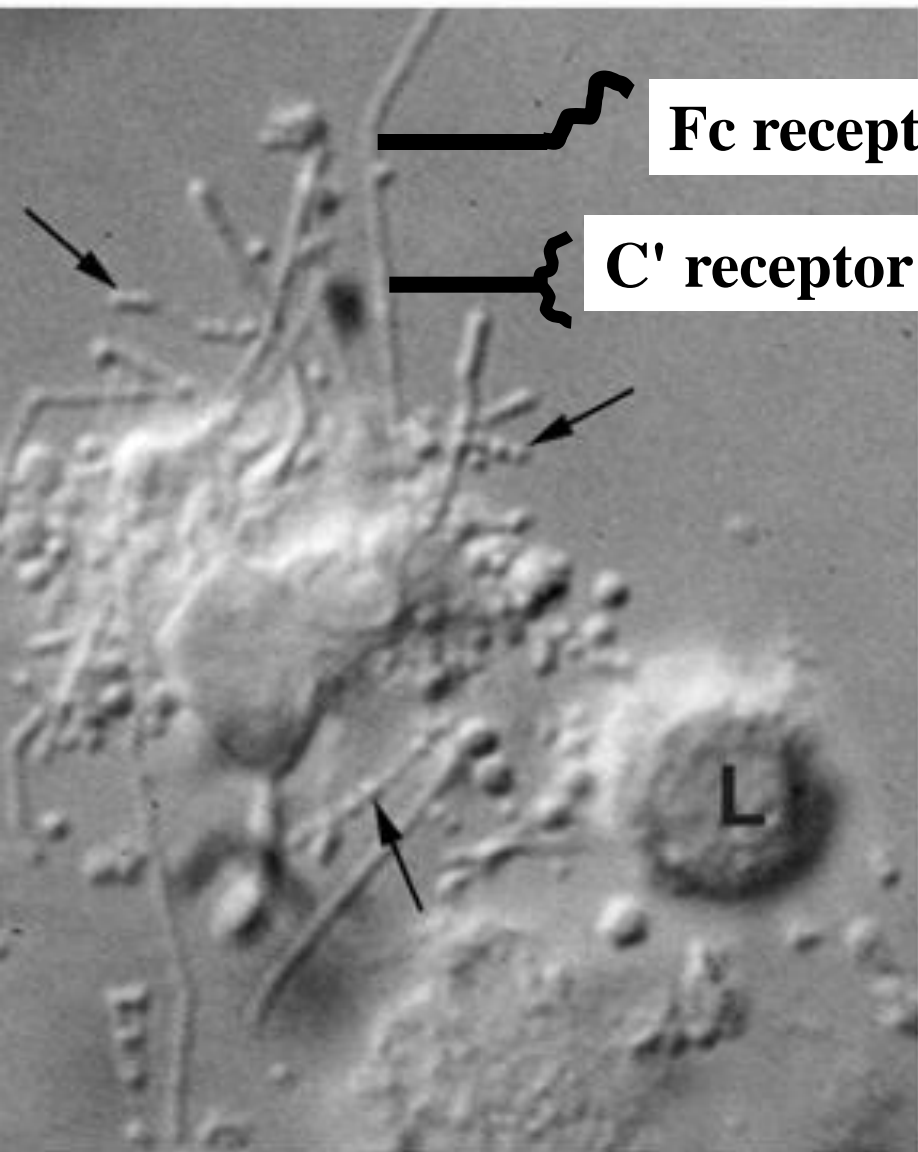


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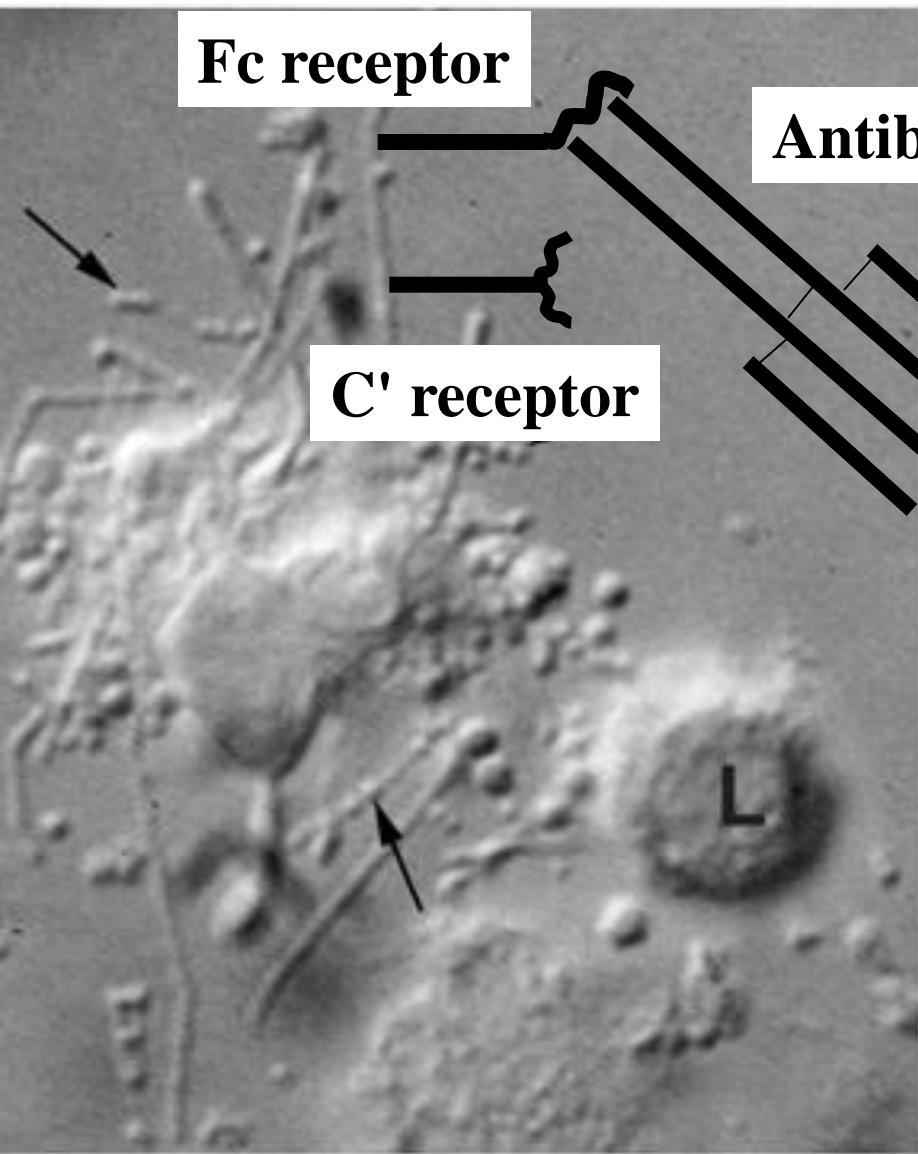
**ICCOSOMES**

**Immune-complex coated bodies**



**Fc receptor**

**C' receptor**

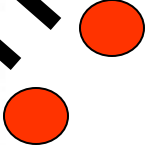


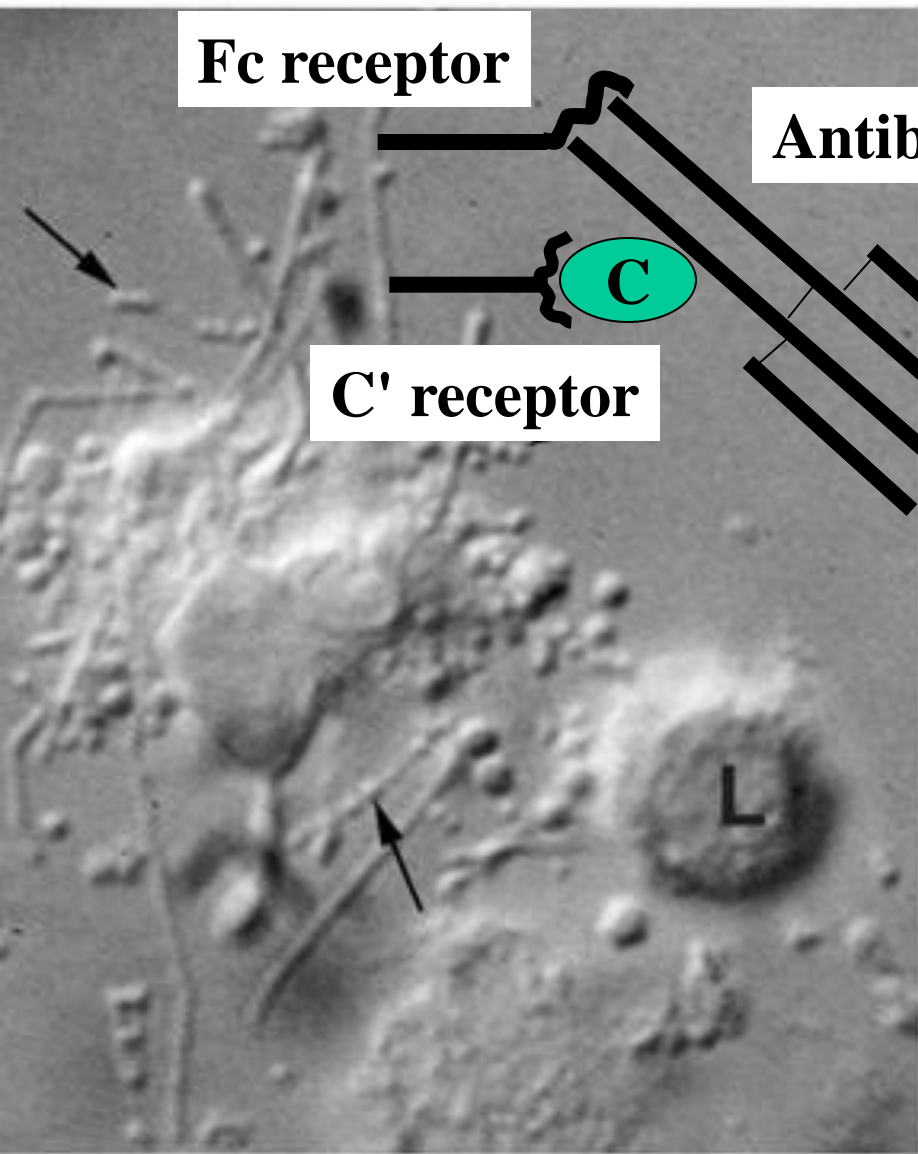
**Fc receptor**

**C' receptor**

**Antibody**

**Antigen**





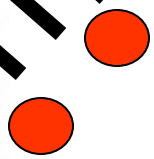
**Fc receptor**

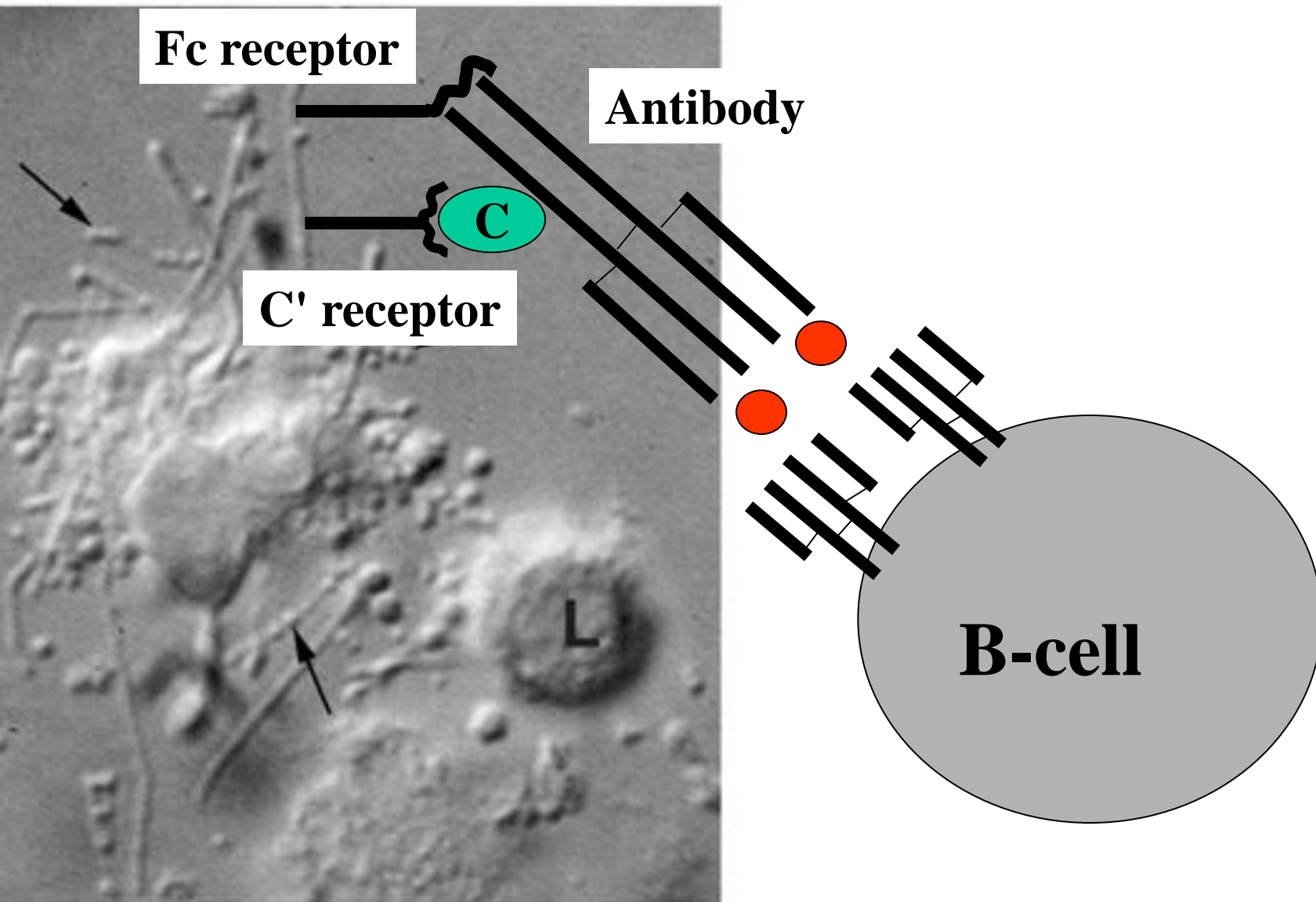
**Antibody**

**C' receptor**

**C**

**Antigen**





## **Adaptive immunity – summary**

- Based on lymphocytes
- Memory
- Specificity