

*u*<sup>b</sup>

# Introduction into the immune system

The cells involved in a “normal” immune response

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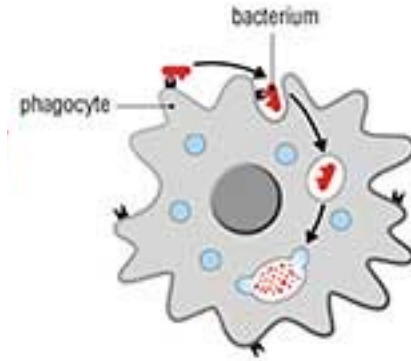


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# The immune systems

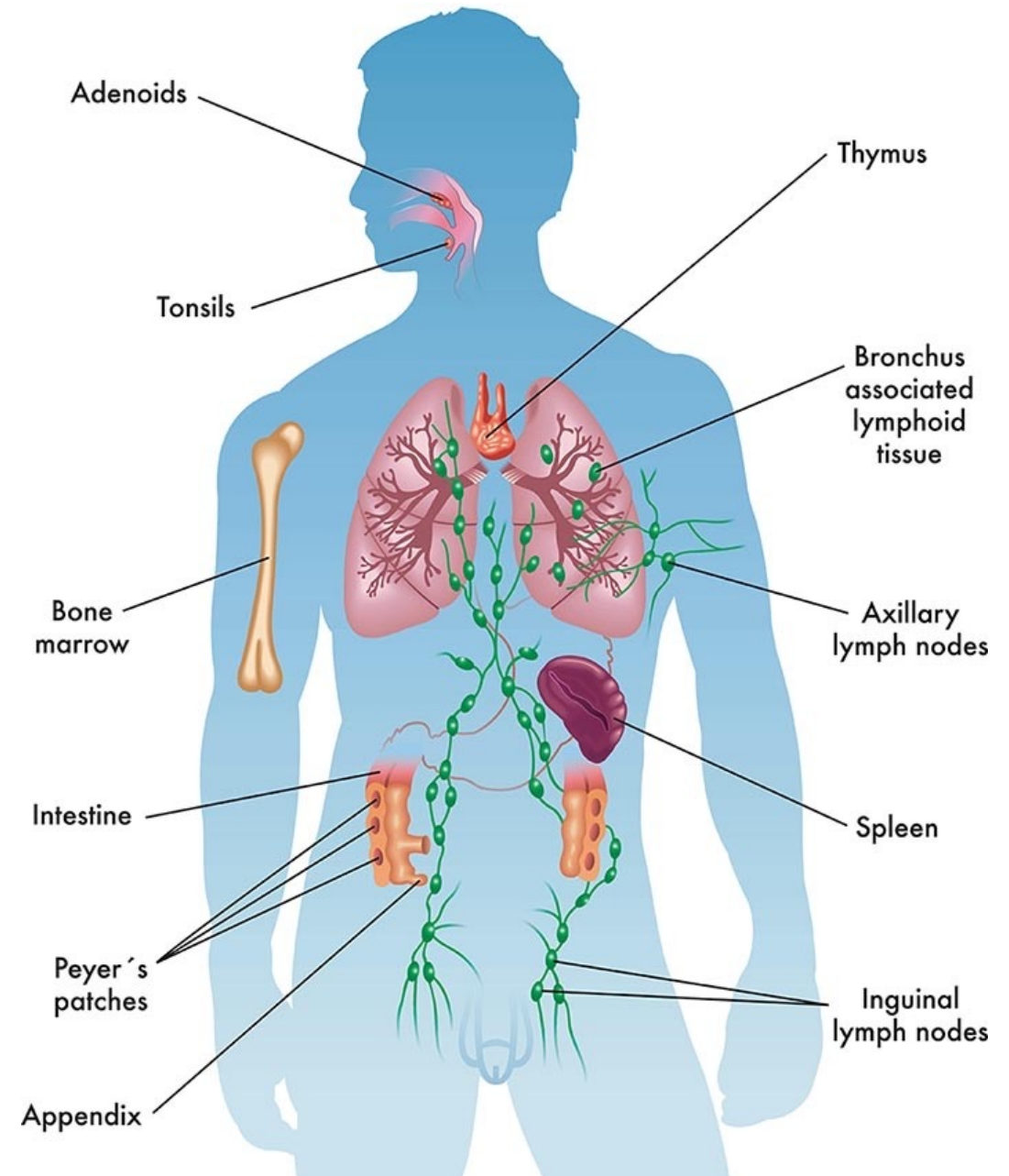
## Innate immune system:

- „*fast but stupid*“
- Mechanical Barriers:
  - Skin, sweat, microbiome
  - Mucus membranes
  - stomach (acid)
- Cells:
  - Macrophages, Neutrophils, ...



## Adaptive immune system:

- „*slow and clever*“
- cells:
  - B-cells, T-cells, ...



# David Vetter – „Bubble Boy“

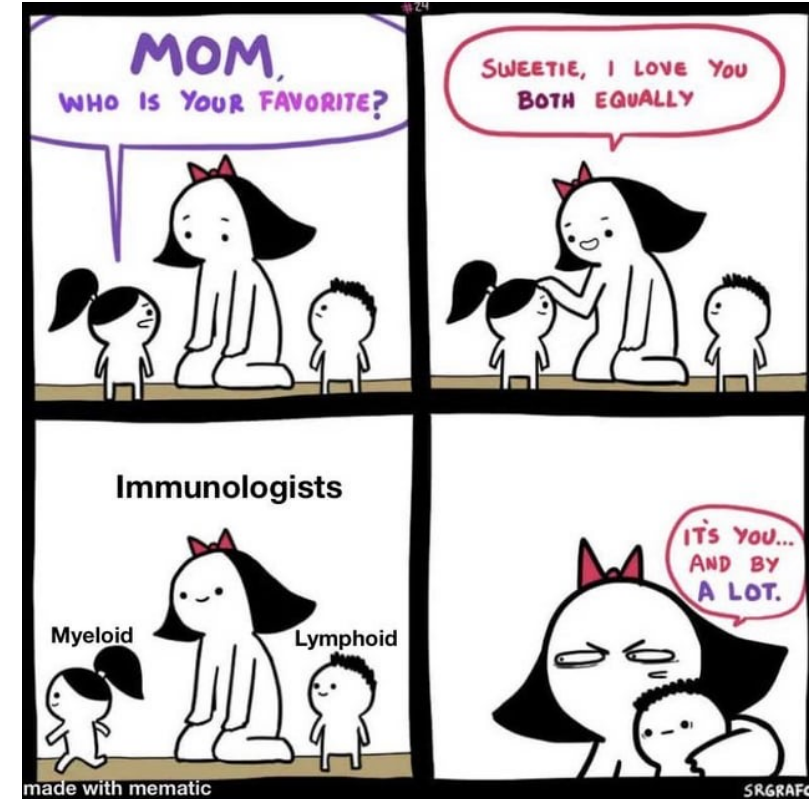
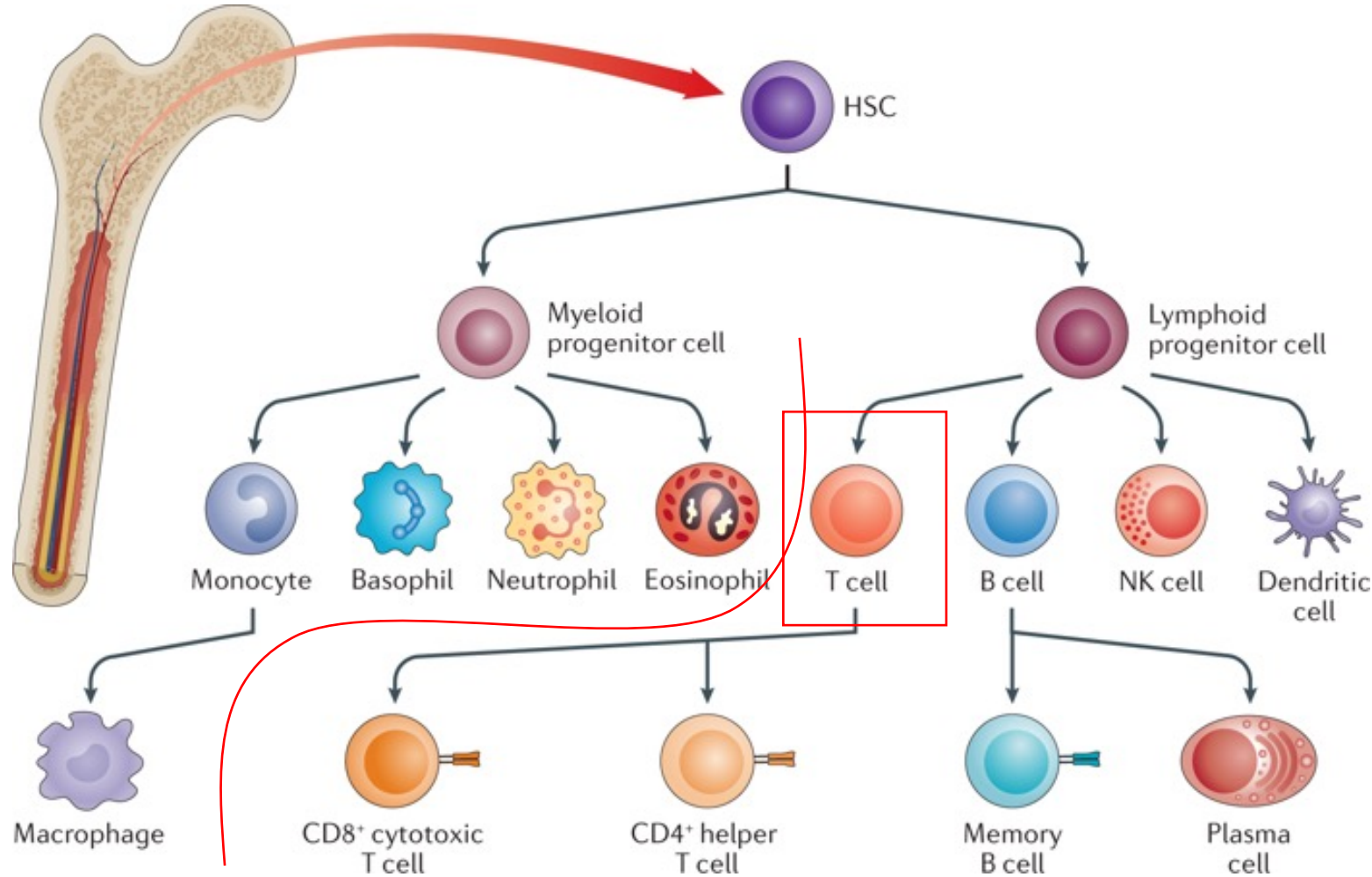


Severe Combined Immunodeficiency (SCID)

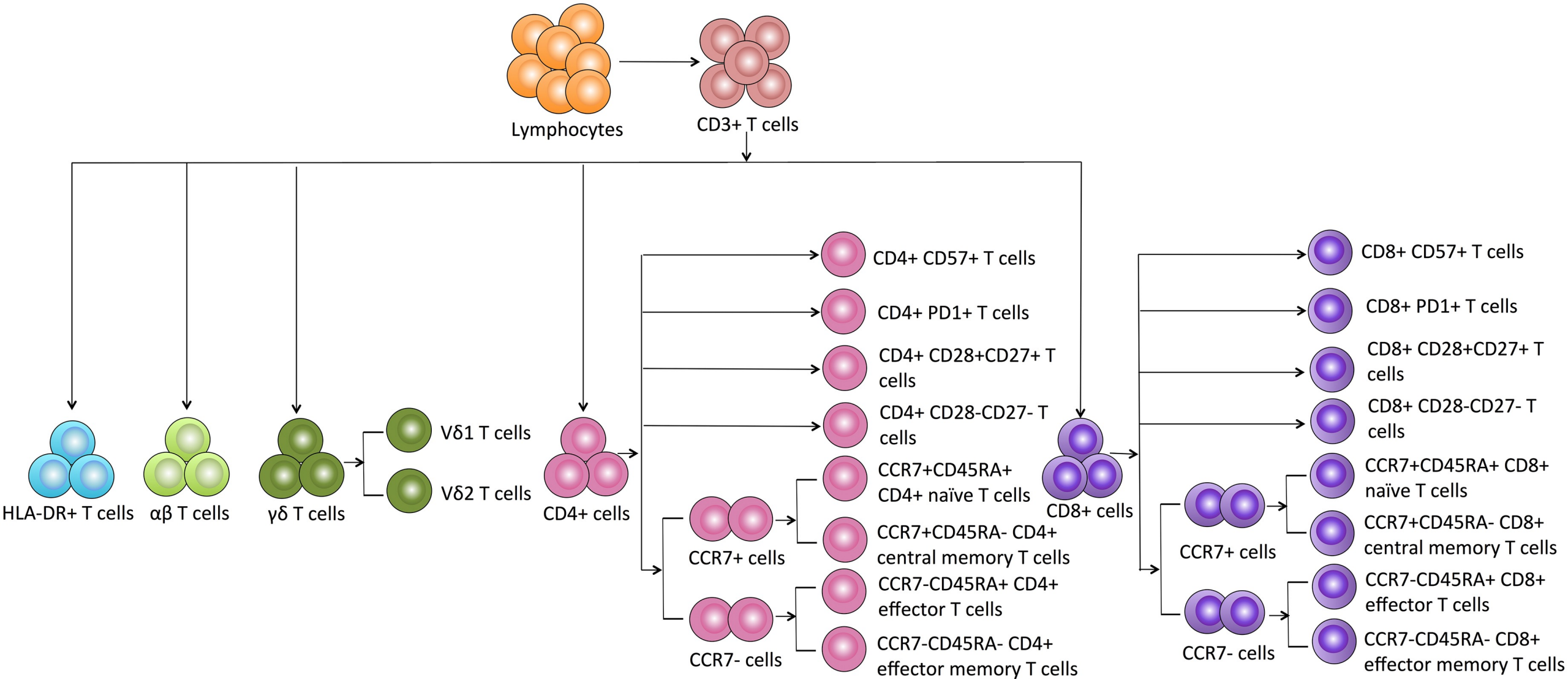


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# The cells of the immune system



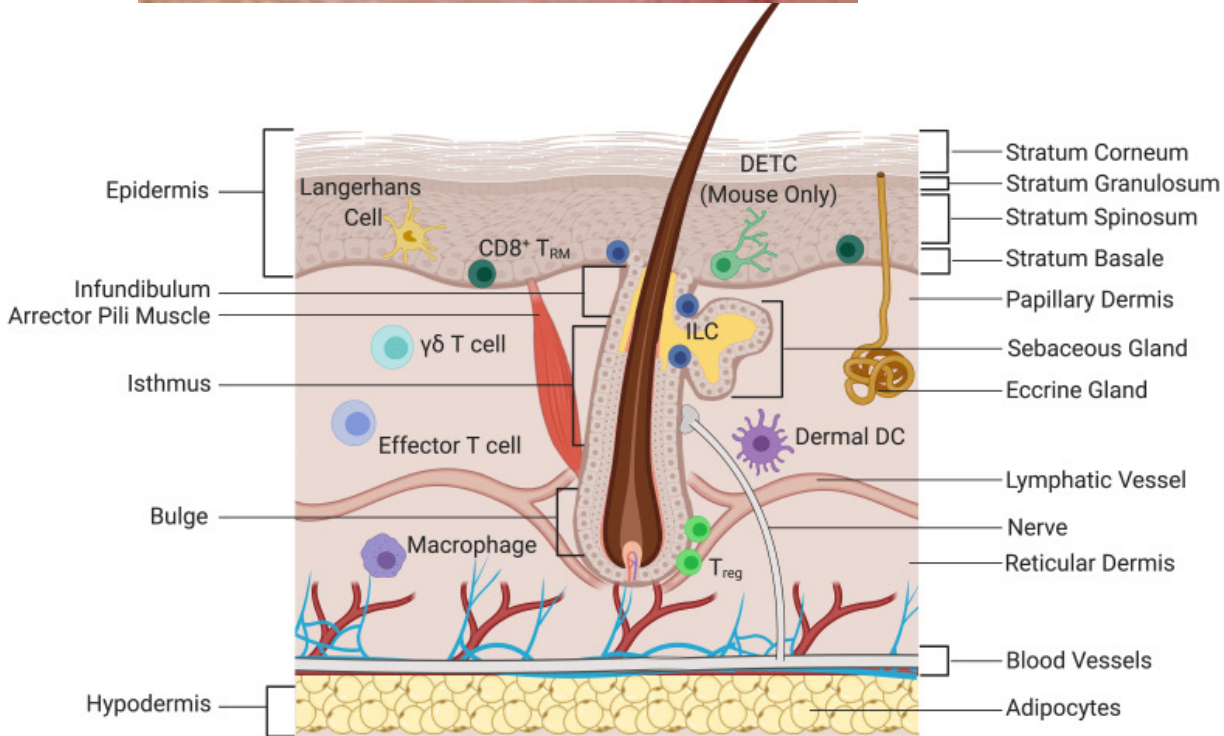
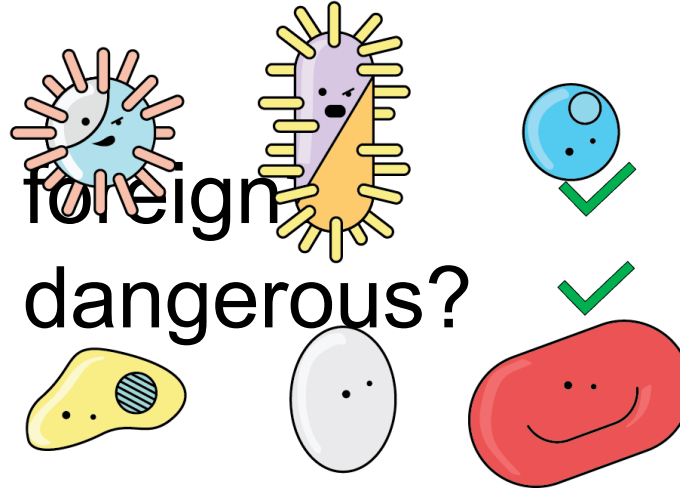
# The world of T cells



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Is it foreign?  
Is it dangerous?



Foreign?

Toll like receptors (TLR)

- cell wall
- liposaccharides
- flagellin

Dangerous?

are Things that should be inside cells now outside (DNA, IL-1b)



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# Macrophages and Monocytes



Almost every tissue as it's own version of macrophages.

Brain – Microglia

Liver – Kupfer cells

Lung – Alveolar macrophages

....

When macrophages die they get replaced by monocytes from the blood that become macrophages or DCs.

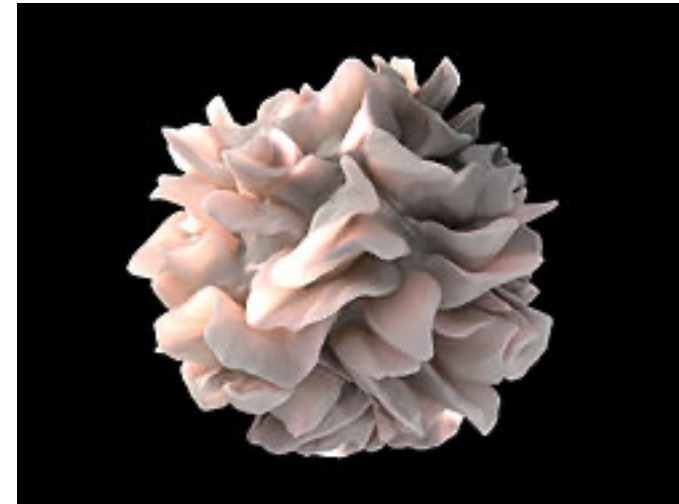
Monocyte derived MP or DCs are not as "good" as the OGs



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# Dendritic cells (DCs)

Eat bacteria and cell debris and travel via the lymph to the next lymph node

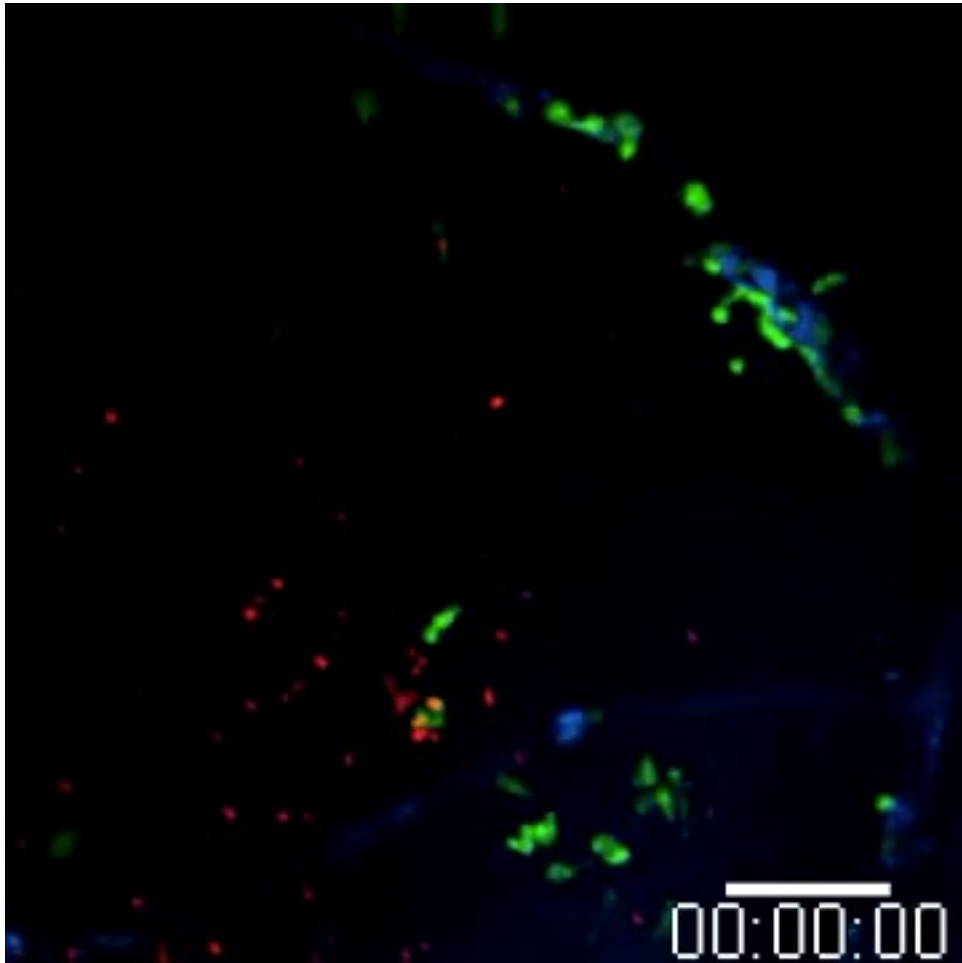


A lot of research is currently done to find out how many versions of DCs there are.

At least two: conventional DCs (cDC 1 and cDC 2) and pDCs

It is not always clear if a cell is a DC or a macrophage (eg. Langerhans cells in the skin) especially when it is monocyte derived.

# $u^b$ Neutrophils

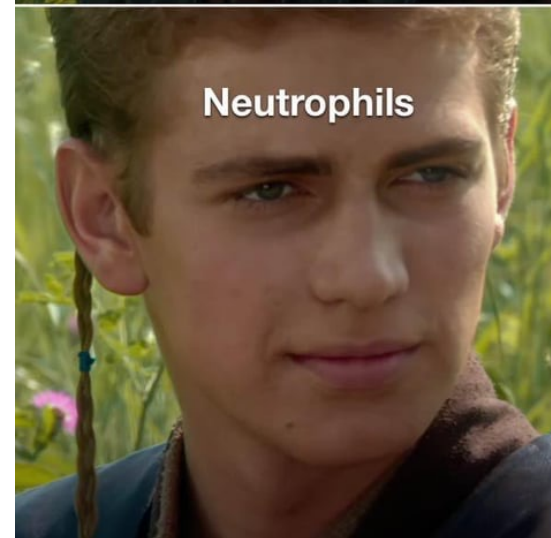
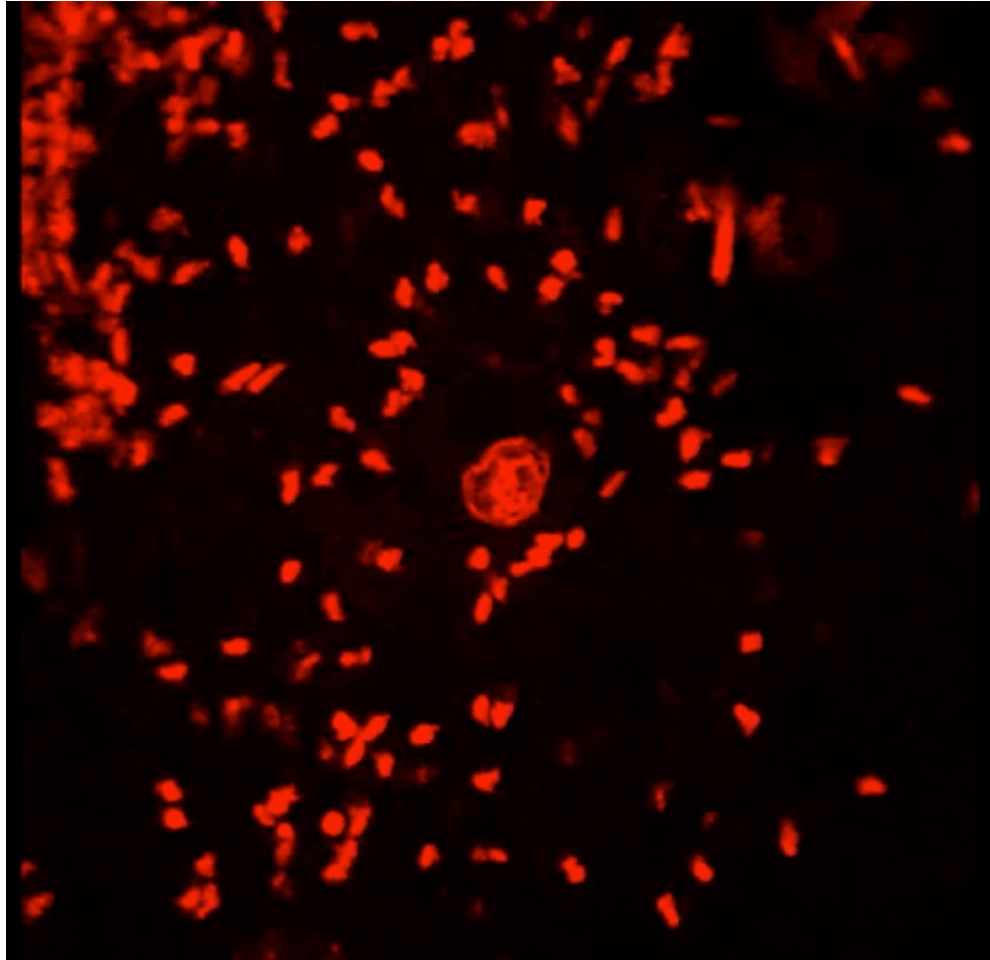


Blue – Blood vessels  
Red – Bacteria  
Green – Neutrophils

- Most common white blood cells (50 - 65%)
- Tasks: Identify and destroy microorganisms
- Every day the human body produces over 100 billion neutrophils in the bone marrow
- Neutrophils can „vomit out“ their DNA
- Pus is mostly dead neutrophils

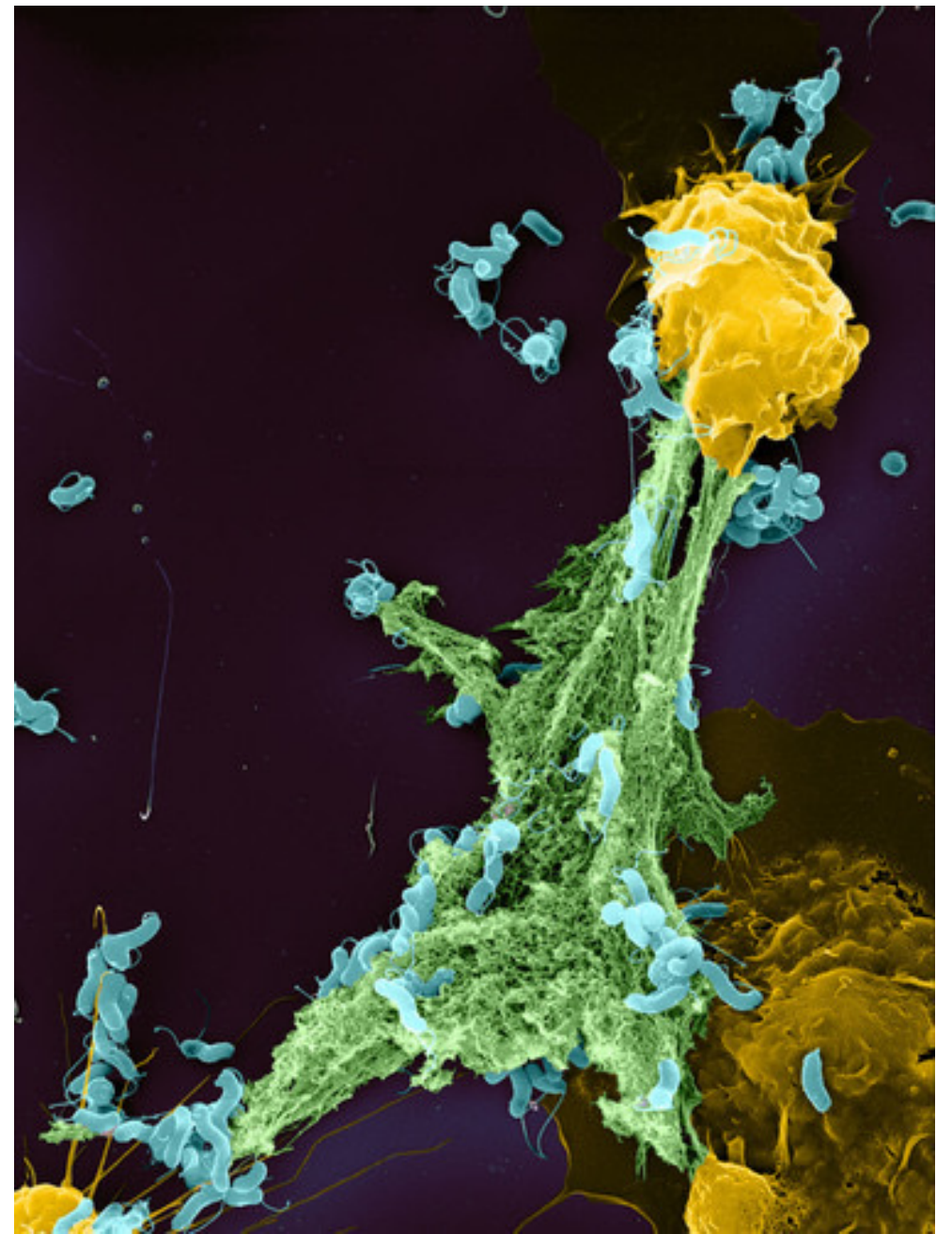
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# Neutrophils



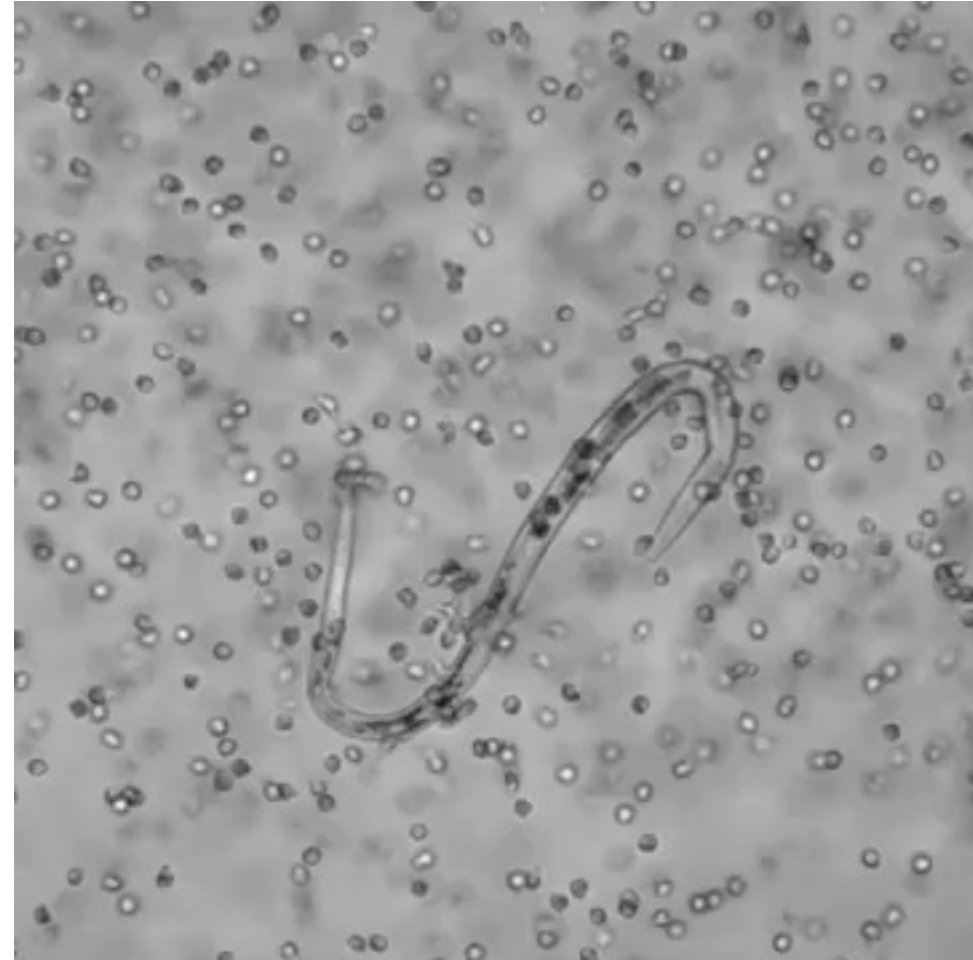


# *u*<sup>b</sup> NETs (Neutrophil extracellular traps)

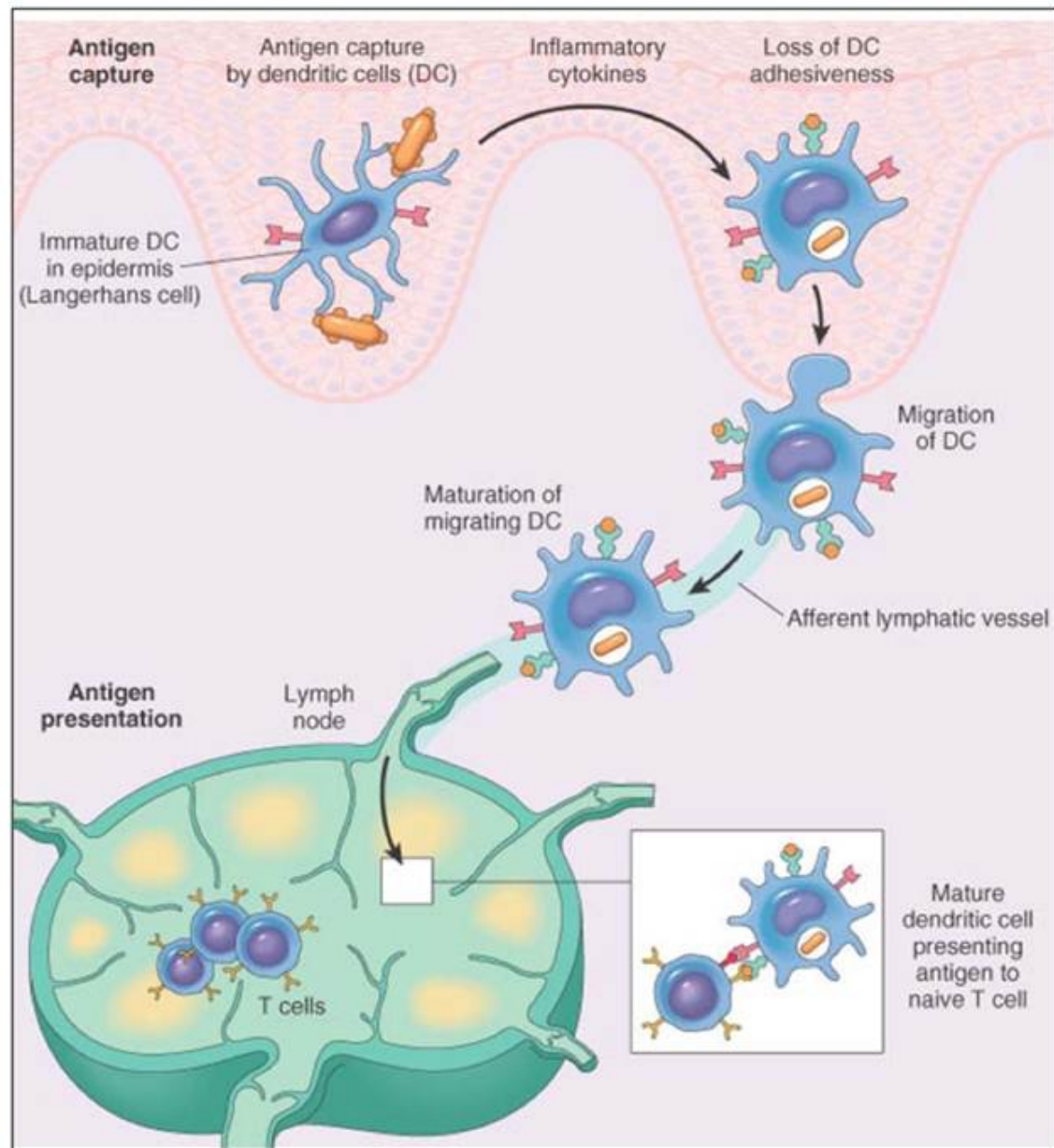




# Eosinophil vs. worm

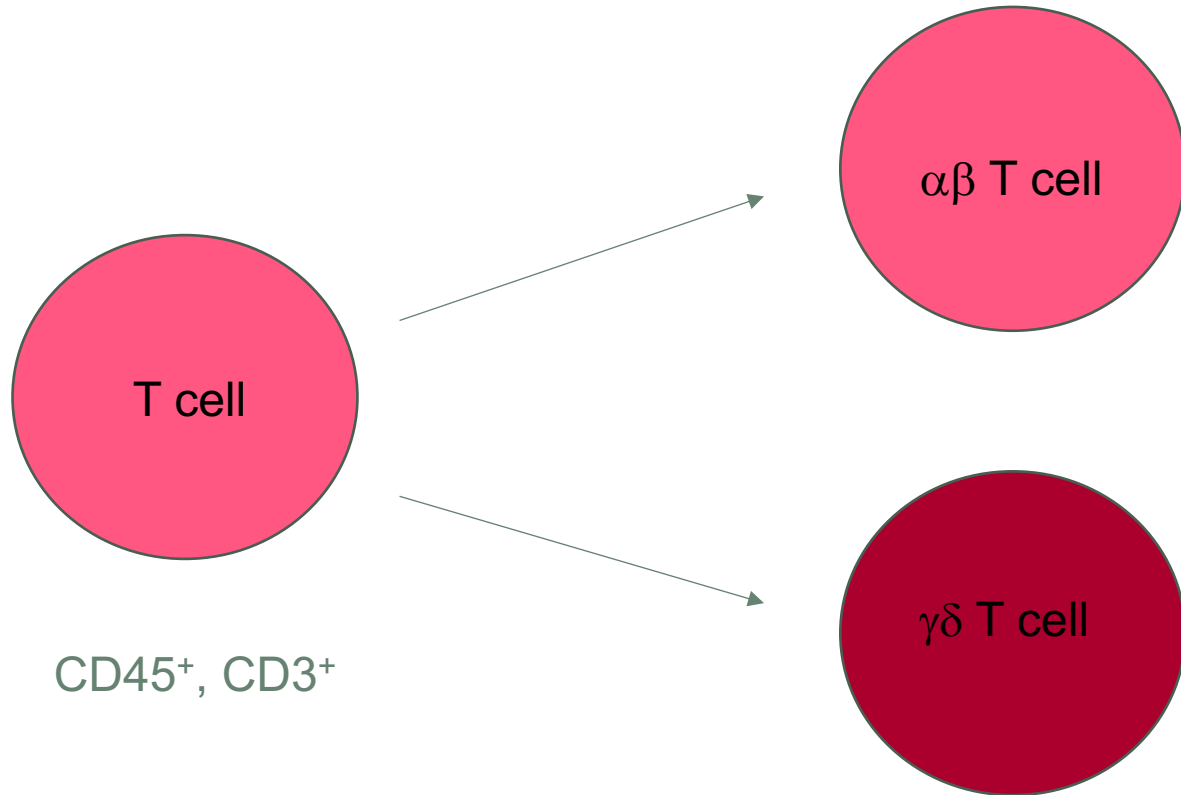


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# What are T cells



CD45<sup>+</sup>, CD3<sup>+</sup>

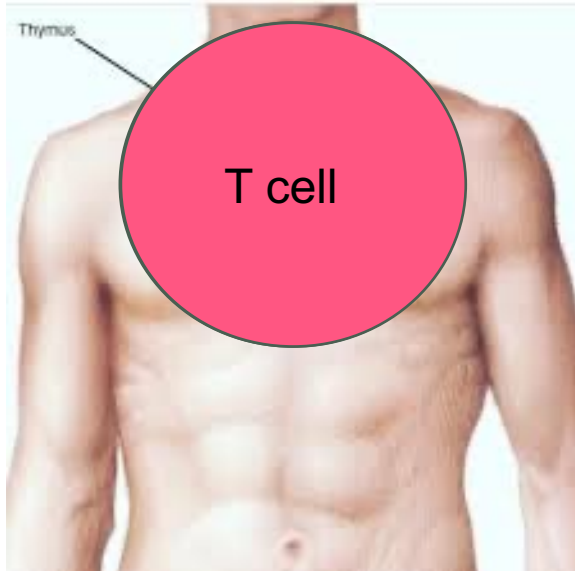
- CD4<sup>+</sup> or CD8<sup>+</sup> T cells
- In humans 90-95% of CD3<sup>+</sup> cells are  $\alpha\beta$  T cells  
CD45<sup>+</sup>, CD3<sup>+</sup>, CD4<sup>+</sup> or CD8<sup>+</sup>

- Real function still not completely understood.
- A lot of animals (sheep, pigs) have 80%  $\gamma\delta$  T cell

CD45<sup>+</sup>, CD3<sup>+</sup>,  
TCRgd<sup>+</sup>

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# CD4<sup>+</sup> T-cells and CD8<sup>+</sup> T-cells



T-helper cells (Th)  
CD4<sup>+</sup> T-cells  
CD45<sup>+</sup>, CD3<sup>+</sup>, CD4<sup>+</sup>



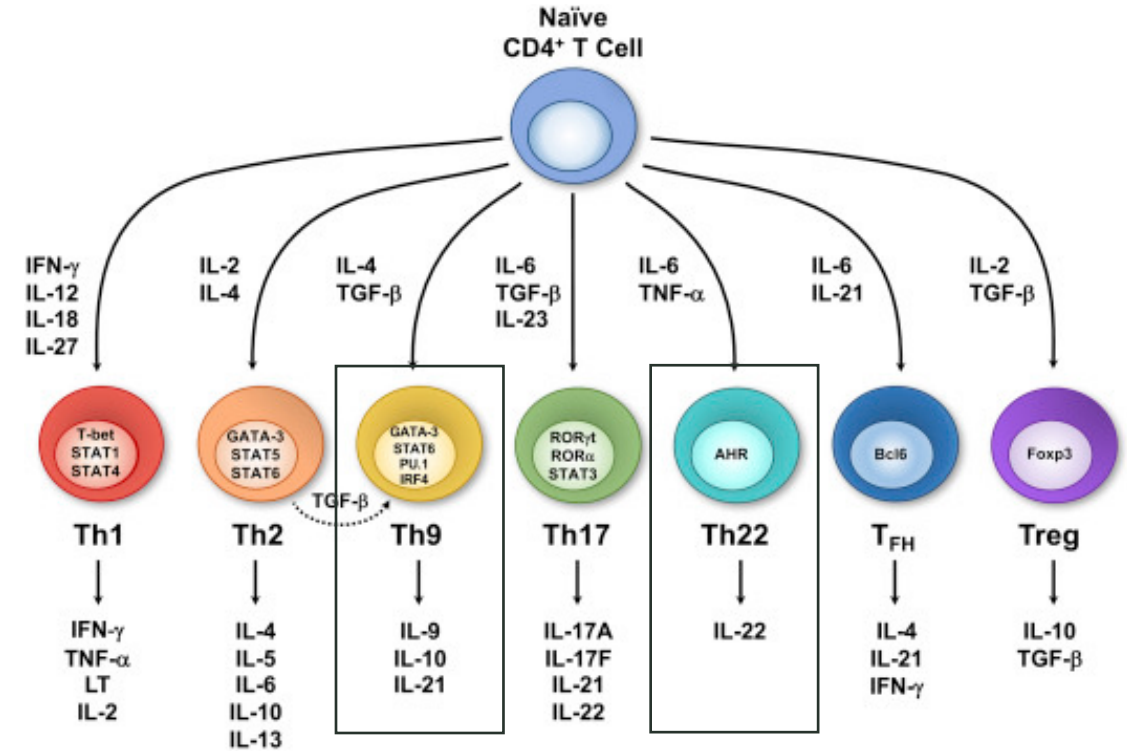
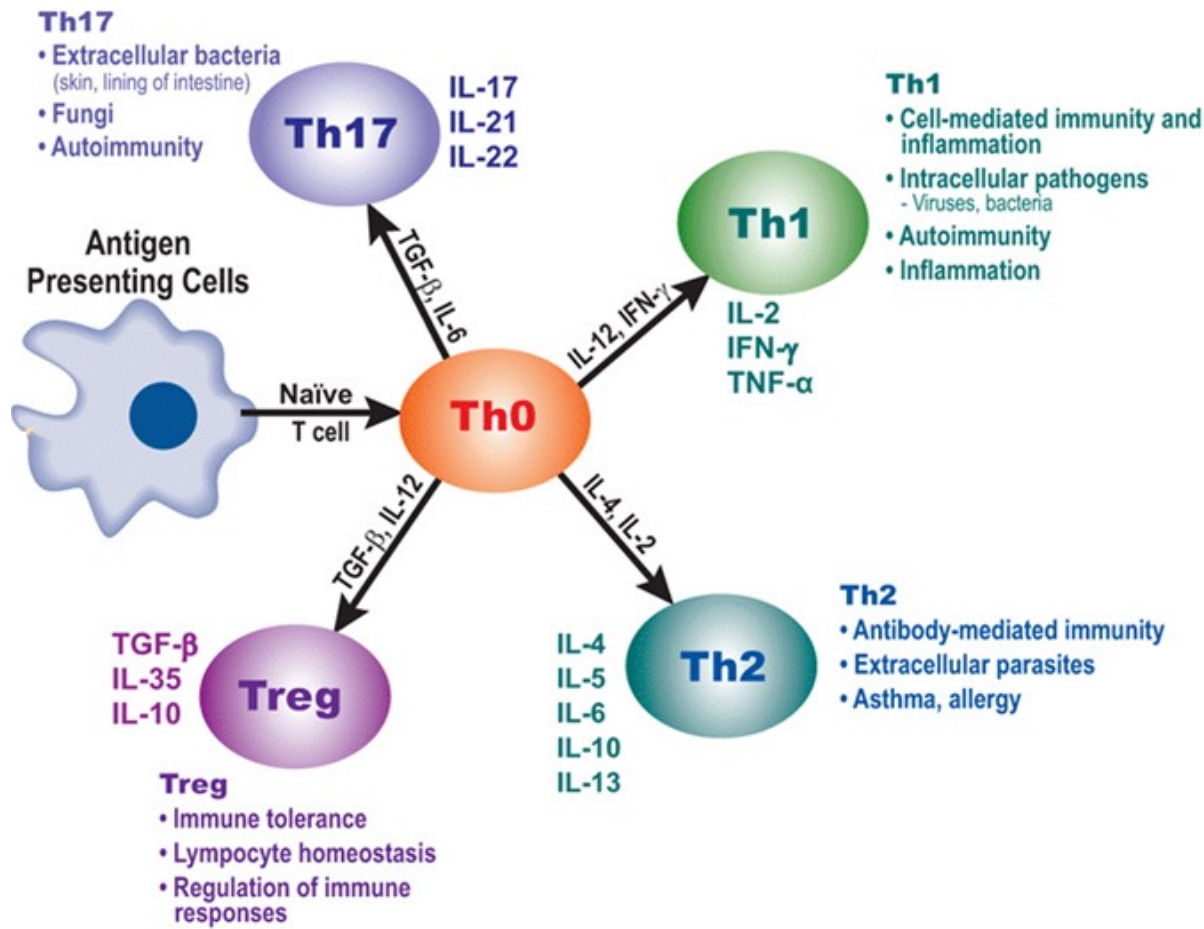
Regulatory T cells  
T<sub>regs</sub>  
CD45<sup>+</sup>, CD3<sup>+</sup>, CD4<sup>+</sup>, CD25<sup>+</sup>,  
Foxp3<sup>+</sup>



T-killer cells  
Cytotoxic T cells  
CD8<sup>+</sup> T-cells  
CD45<sup>+</sup>, CD3<sup>+</sup>, CD8<sup>+</sup>



# Th1, Th2, Th17, ... or more



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### Th1:

- Fight against intracellular Bacteria as well as viral infections
- Activation of **macrophages**
- Stimulates **natural killer cells** und **cytotoxic T cells**

### Th2:

- Fight against microorganisms and worms
- Stimulates **mast cells** and **basophils** as well as **eosinophils**

### Th17:

- Fight against bacterial- and fungal infections
- Over activation leads to Autoimmune diseases
- Activation of **macrophages**
- Recruitment of additional **neutrophils**



# $u^b$ Tregs (regulatory T cells)

Tregs control the immune response to self and foreign particles (antigens)

- They help prevent autoimmune disease.
- Protect the fetus from the immune system
  - Mice without Tregs have a near 100% abortion rate



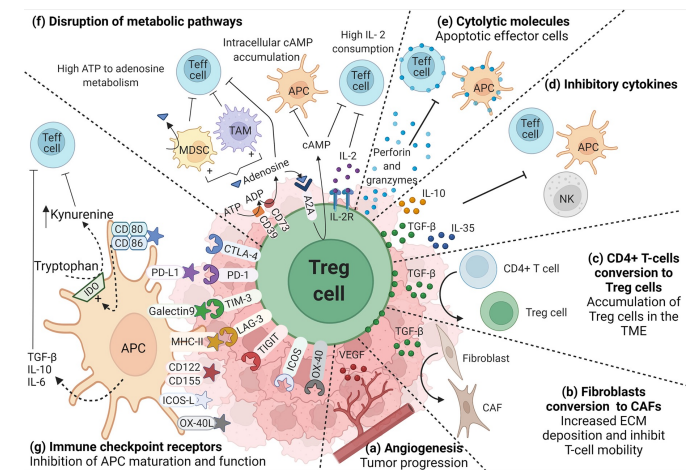
Published: 01 February 2004  
**Regulatory T cells mediate maternal tolerance to the fetus**

Varuna R Aluvihare, Marinos Kallikourdis & Alexander G Betz  
 Nature Immunology 5, 266-271 (2004) | Cite this article

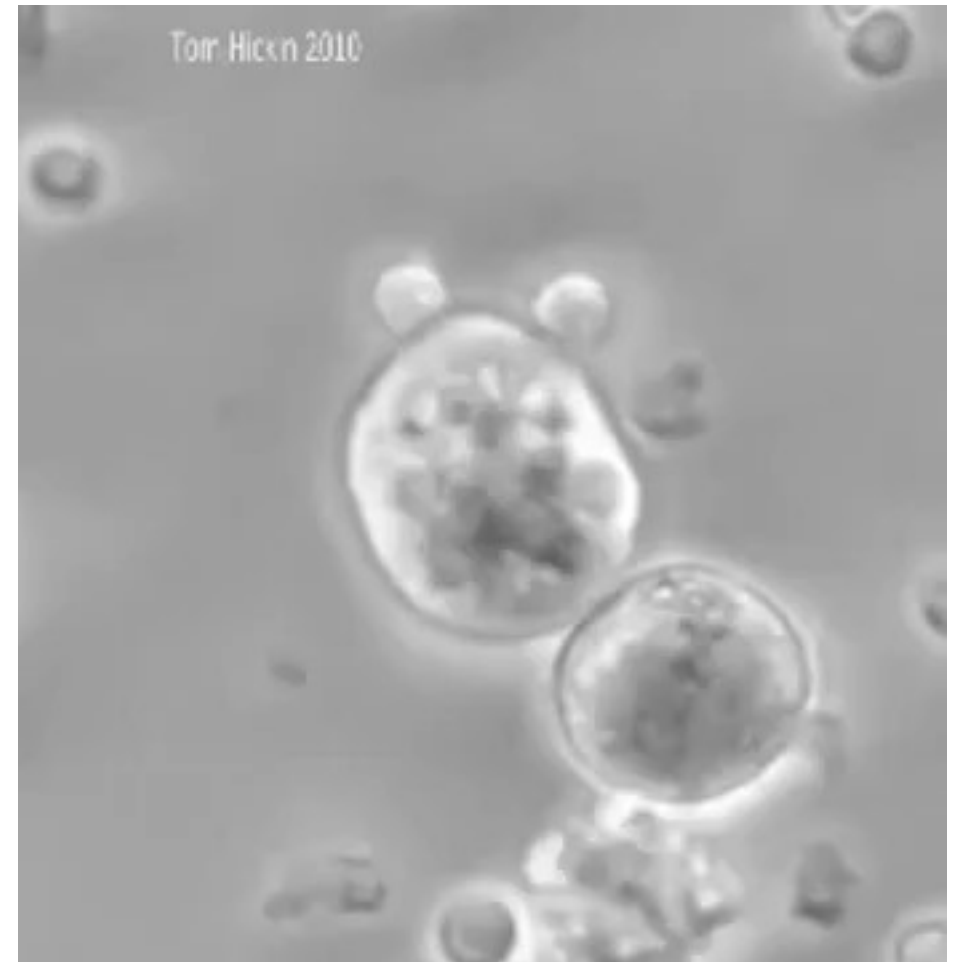
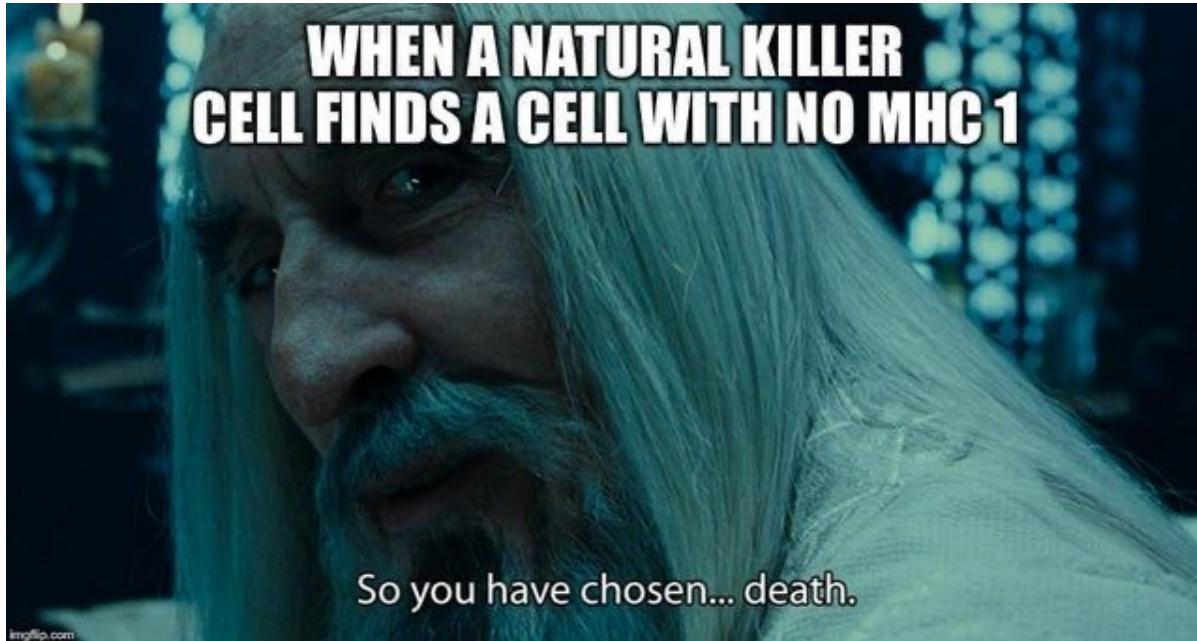
- Some cancers recruit Tregs and are protected from anti-cancer immune response

Colorectal Cancer-Infiltrating Regulatory T Cells: Functional Heterogeneity, Metabolic Adaptation, and Therapeutic Targeting

Sonia Aristin Revilla<sup>1,2,3</sup> Onno Kranenburg<sup>1</sup> Paul J. Coffey<sup>1,2\*</sup>



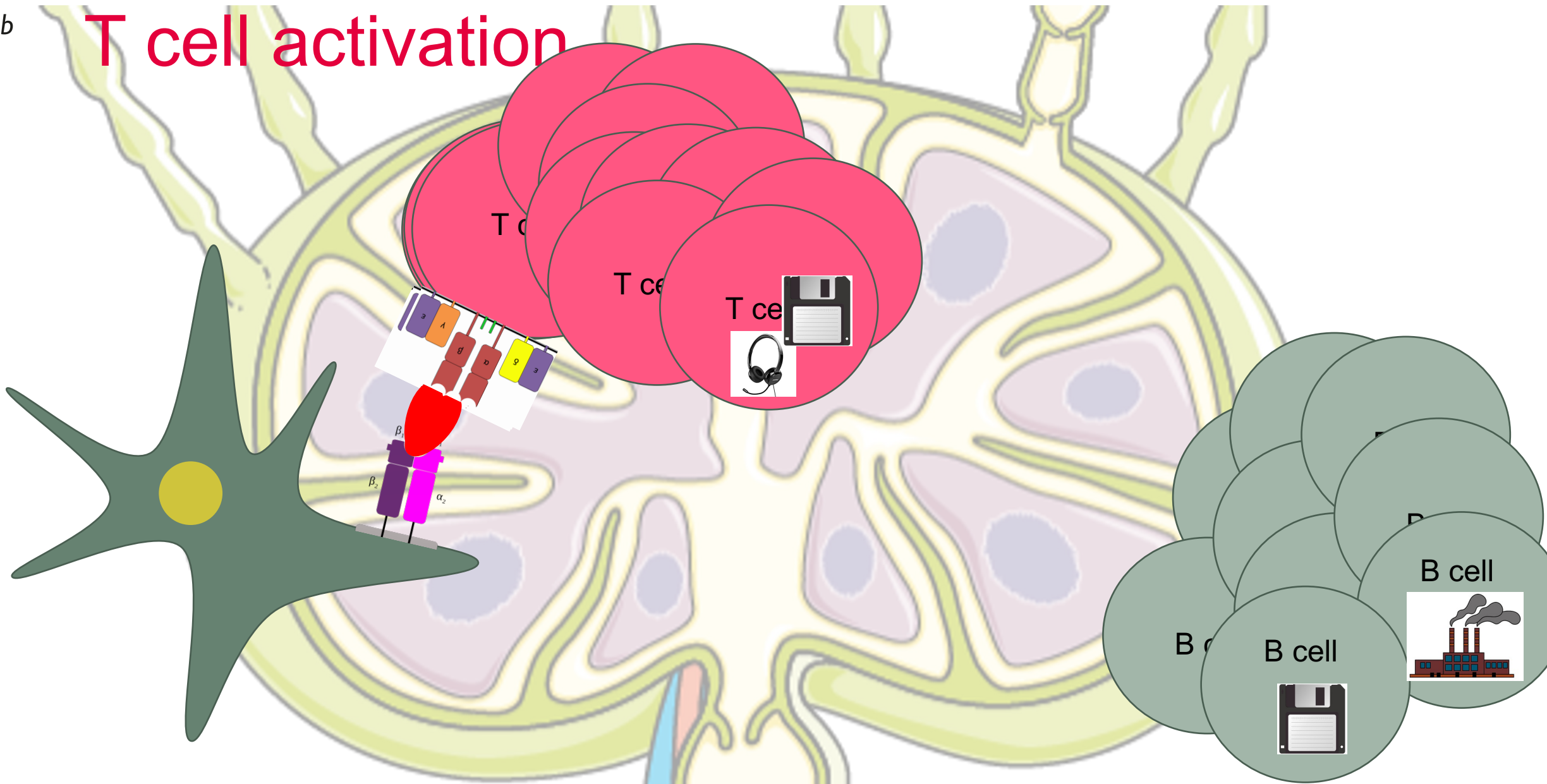
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CD8<sup>+</sup> T cells and NK  
-> the serial killers





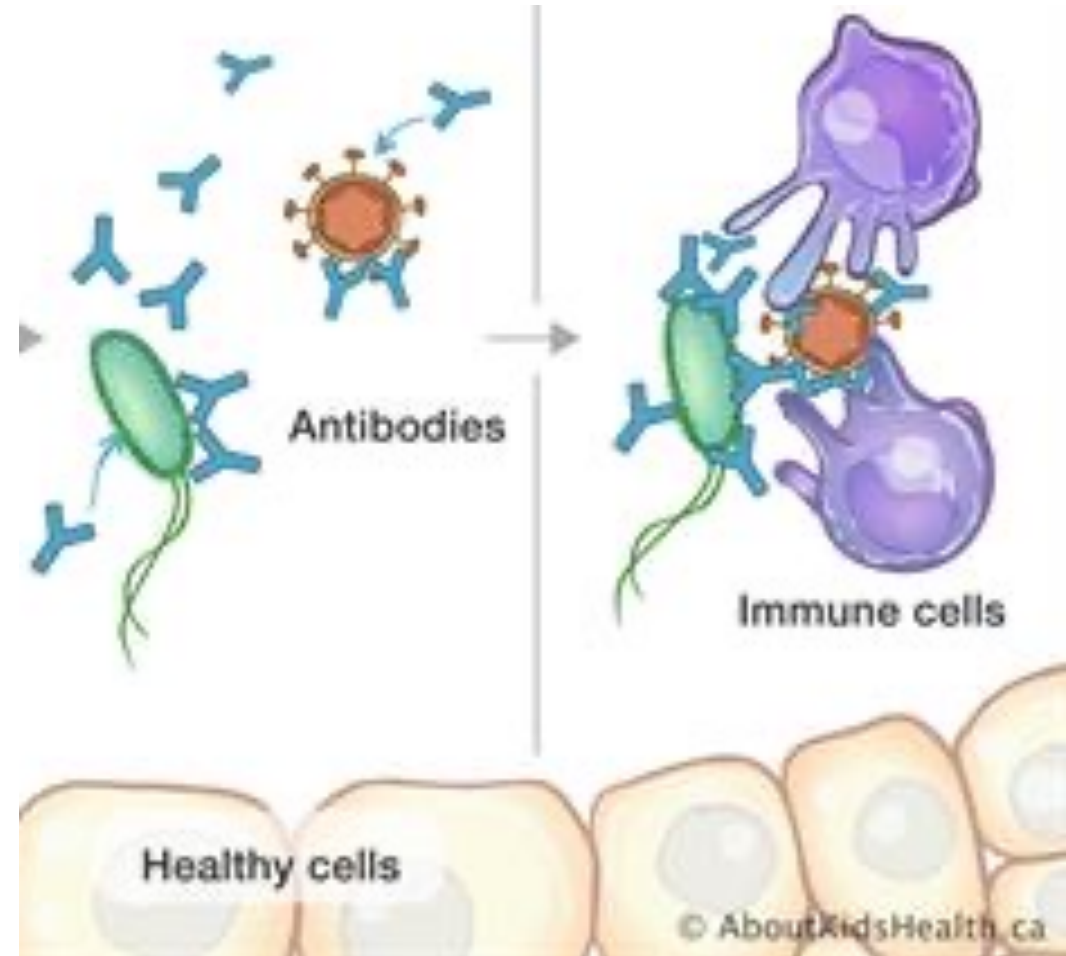
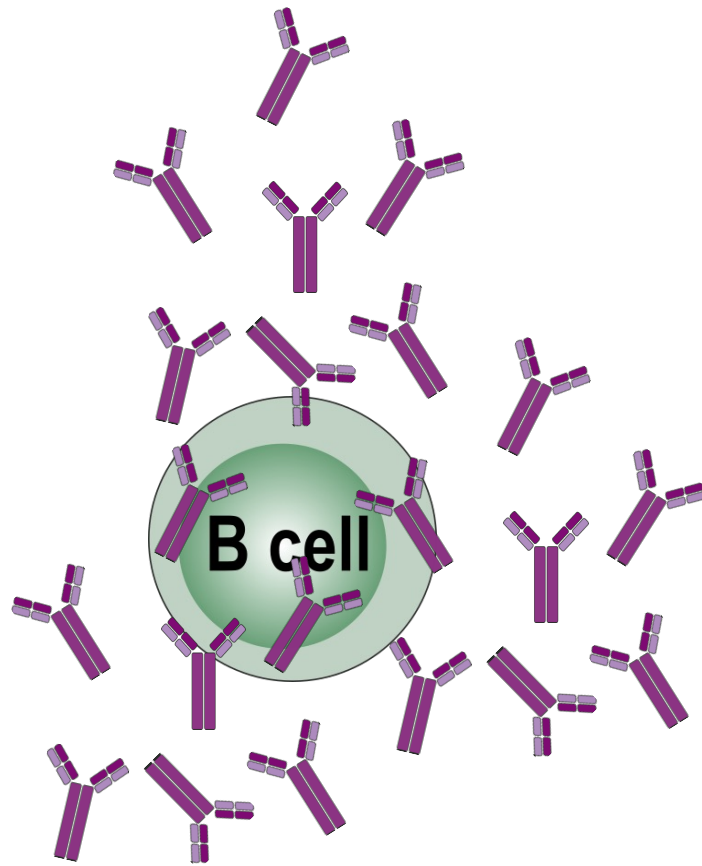
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# T cell activation



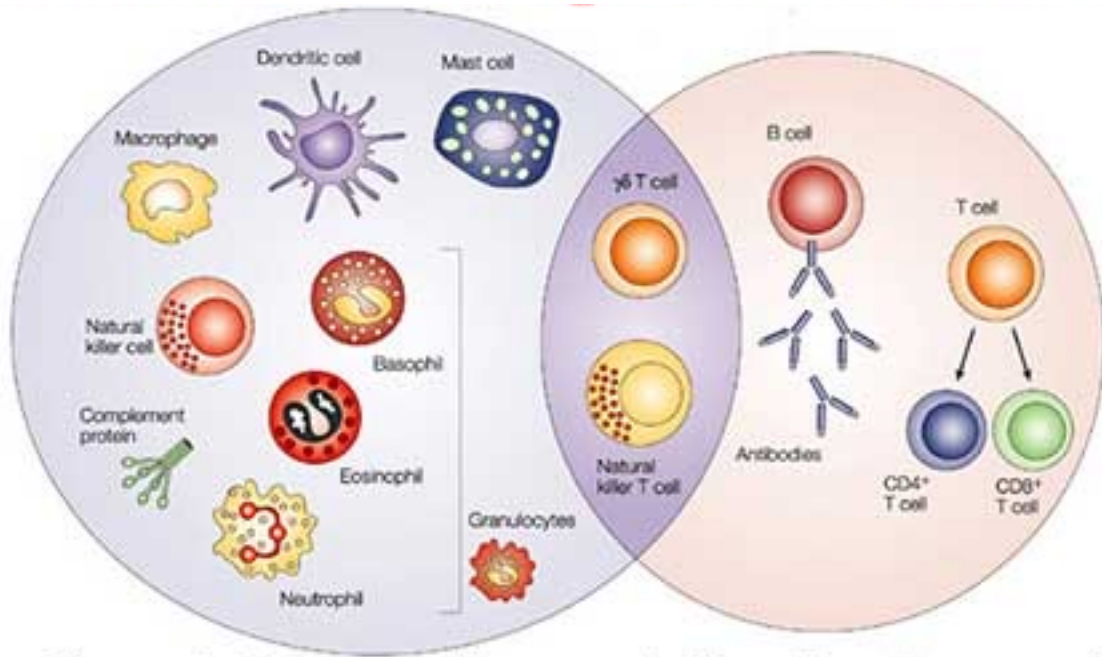
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# Antibody production

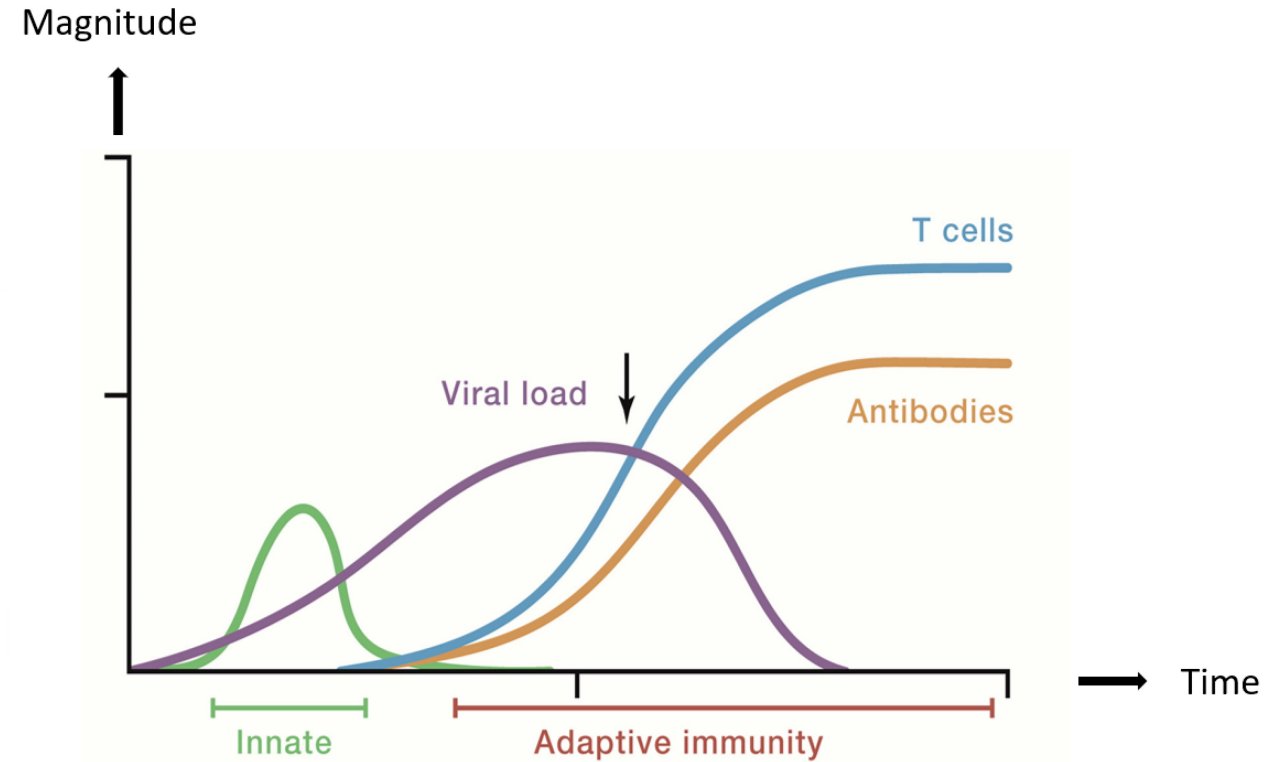


# Why does a cold take 7 days?

# $u^b$ Why does a cold take 7 days.



Innate immune response    Adaptive immune response





# $u^b$ Second exposure to antigen

