



Curso de Ciências Biológicas  
Disciplina BMI0296 – Imunologia



## Aula 1 - Princípios & componentes do sistema imune

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**O que è o sistema imune?**

O que sei sobre imunidade e resposta imune?

# Vacinas para controlar epidemias/pandemias

Ativação da resposta imune & Memória



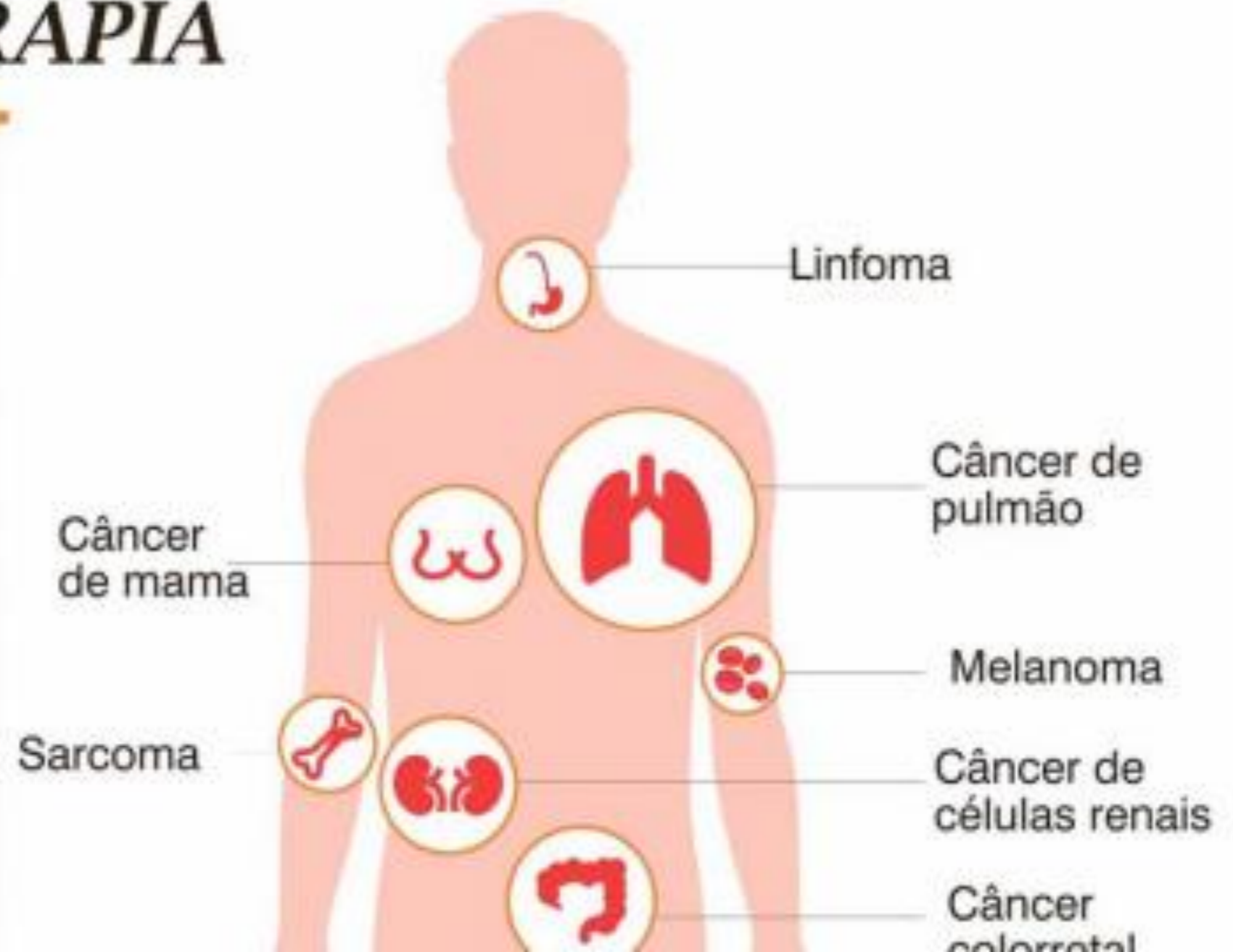
# Imunoterapia para cancer

Ativação da resposta imune para eliminação de tumores

## IMUNOTERAPIA

**Como a imunoterapia oncológica atua?**

Estimulando o sistema imune do paciente a reconhecer e destruir células cancerígenas



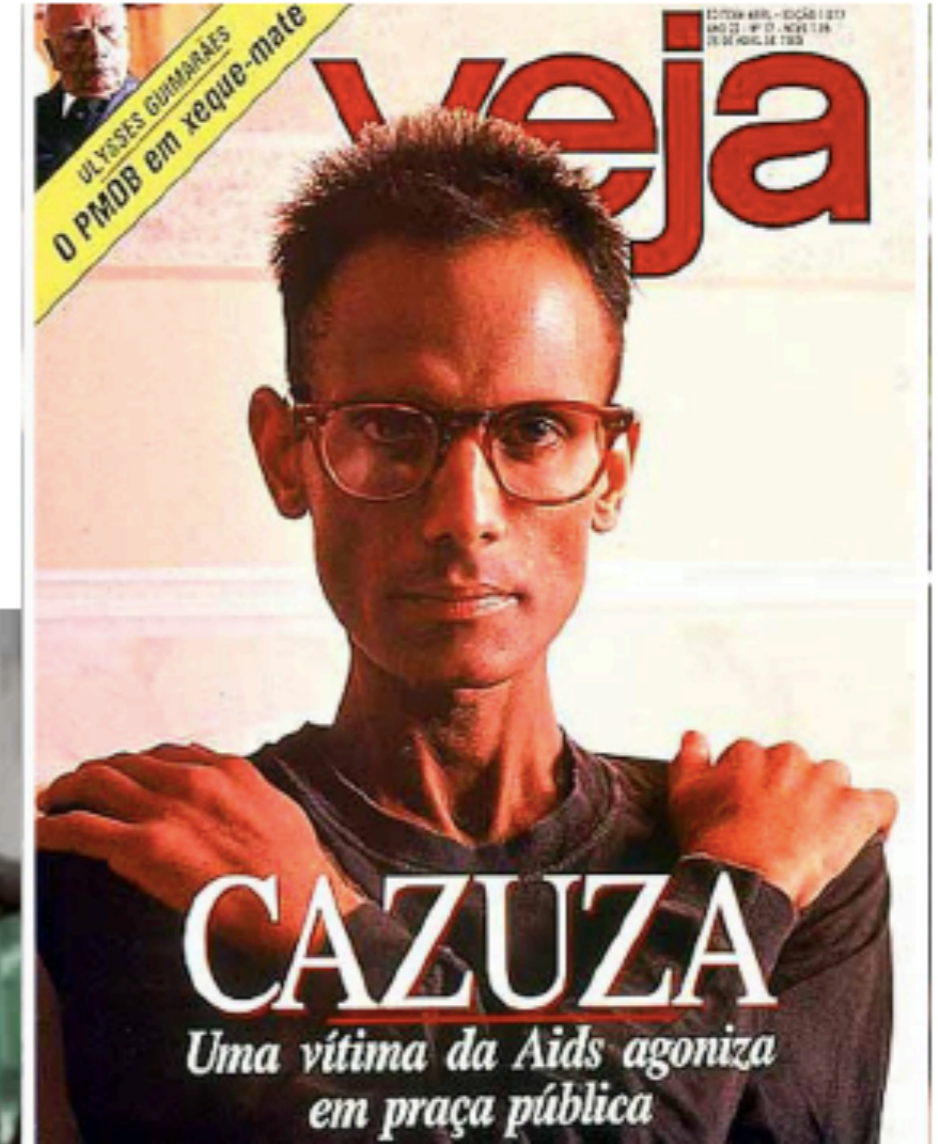
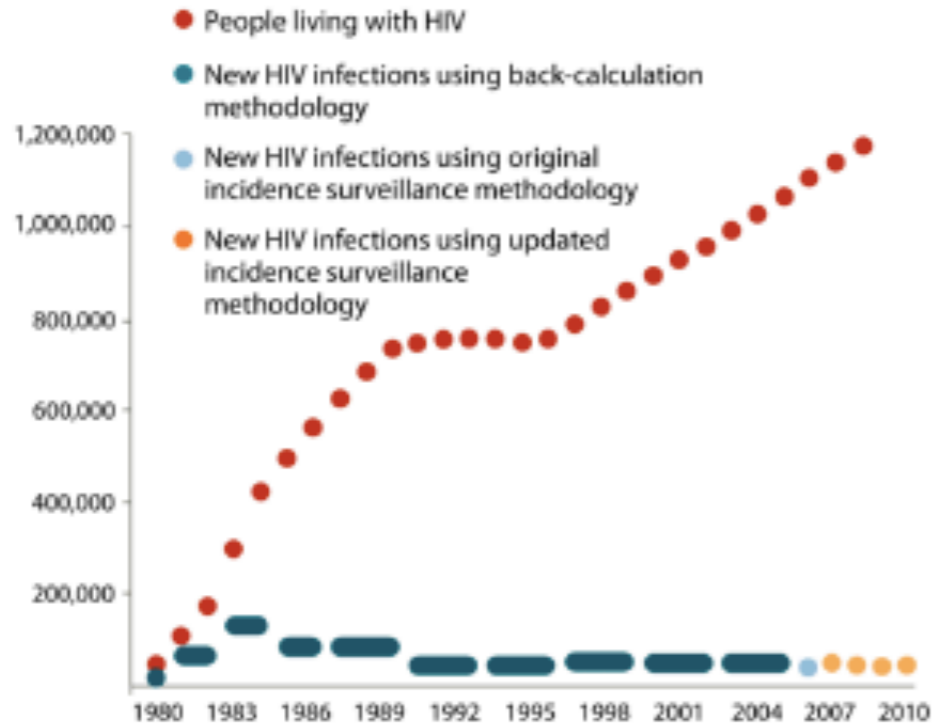
# The “bubble boy” DAVID VETTER (1971-84, TEXAS, USA)



© Bettmann Archive

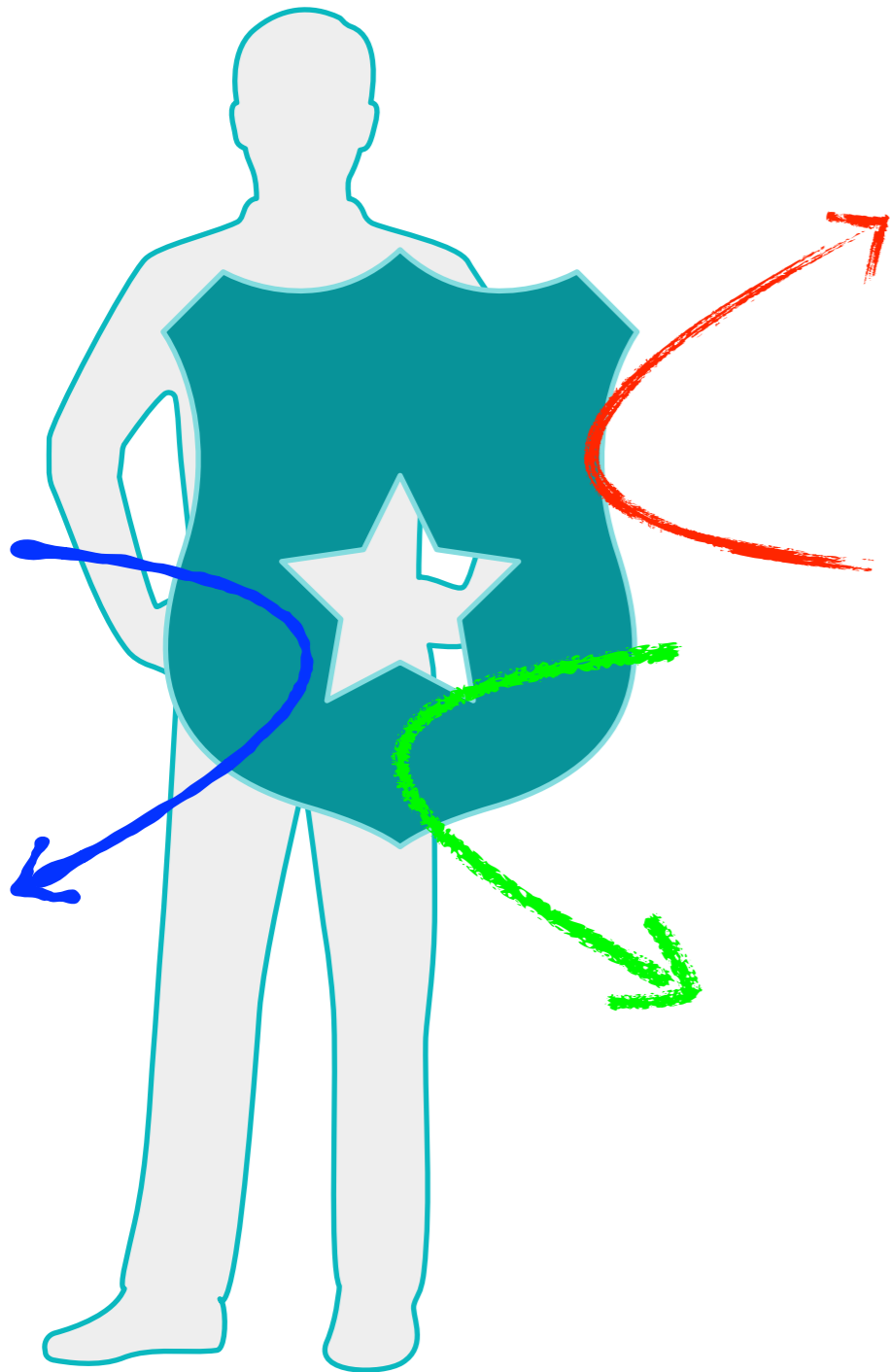
<http://acidcow.com/pics/10855-david-vetter-the-bubble-boy-18-pics.html>

# PANDEMIA DE HIV-1 (1981-)



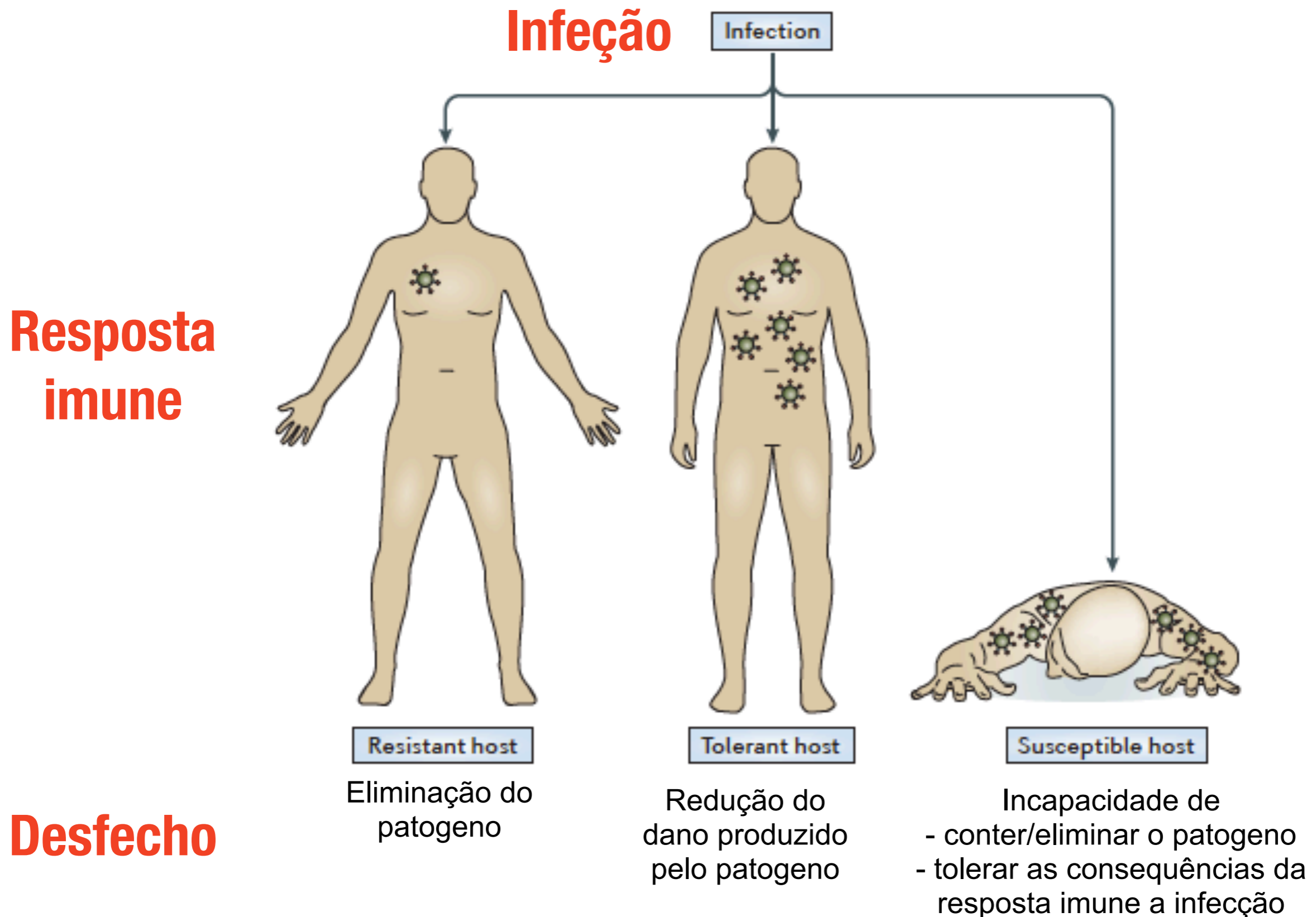
# Imunidade & Sistema imune

**Defesa da infeções e da alterações  
das próprias células**



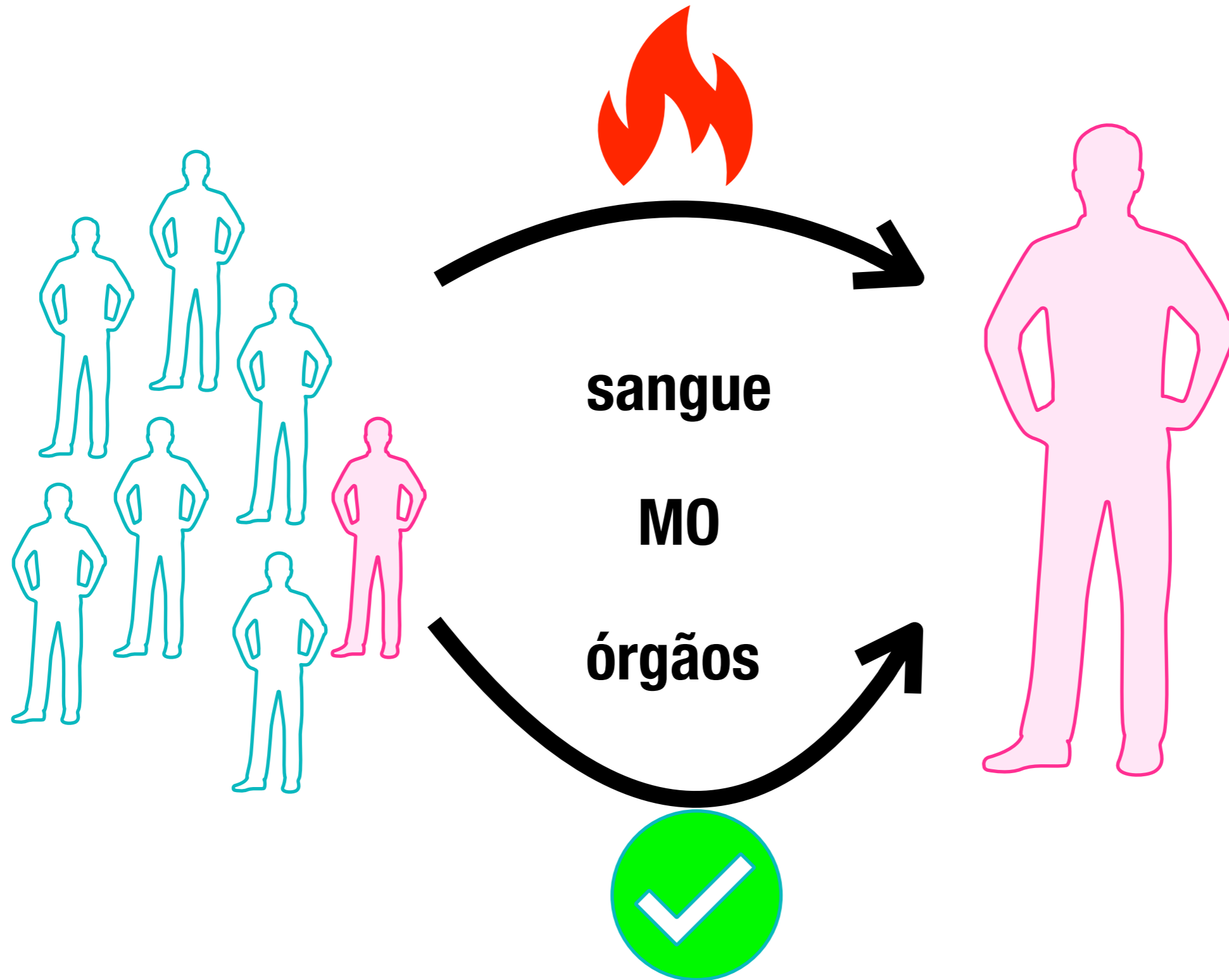
O que queria saber sobre  
imunidade  
e resposta imune?

# Porque as pessoas respondem diferente ?



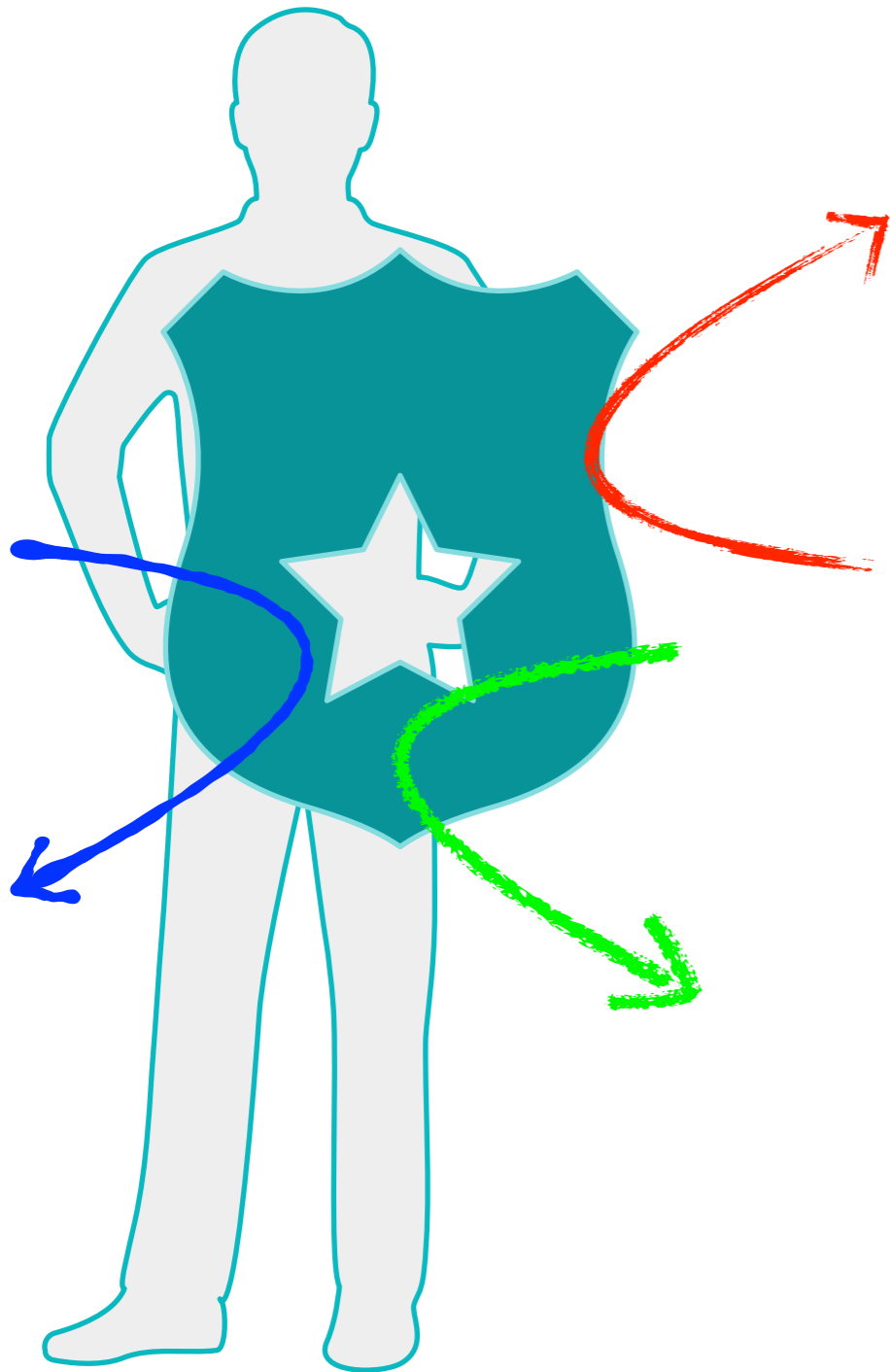


# Porque existem reações de rejeição?



# Imunidade & Sistema imune

**Defesa da infeções e da alterações  
das próprias células**

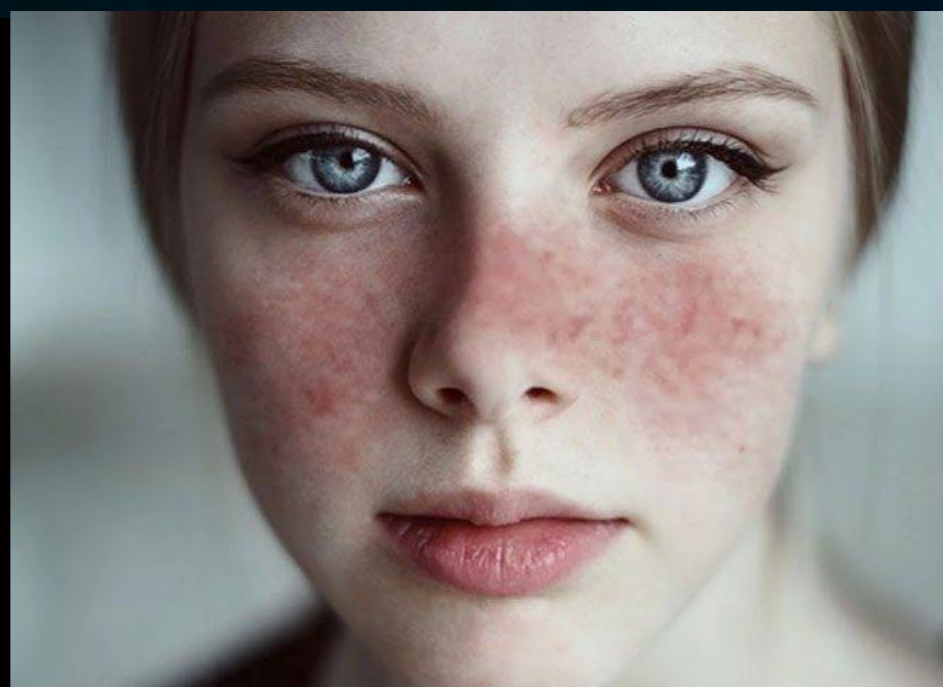


Corredo genómico individual

# Reações de Hipersensibilidade: alergias, asma & cia.



# Doenças autoimunes: artrite reumatoide, lupus, vitiligo



diabete tipo 1

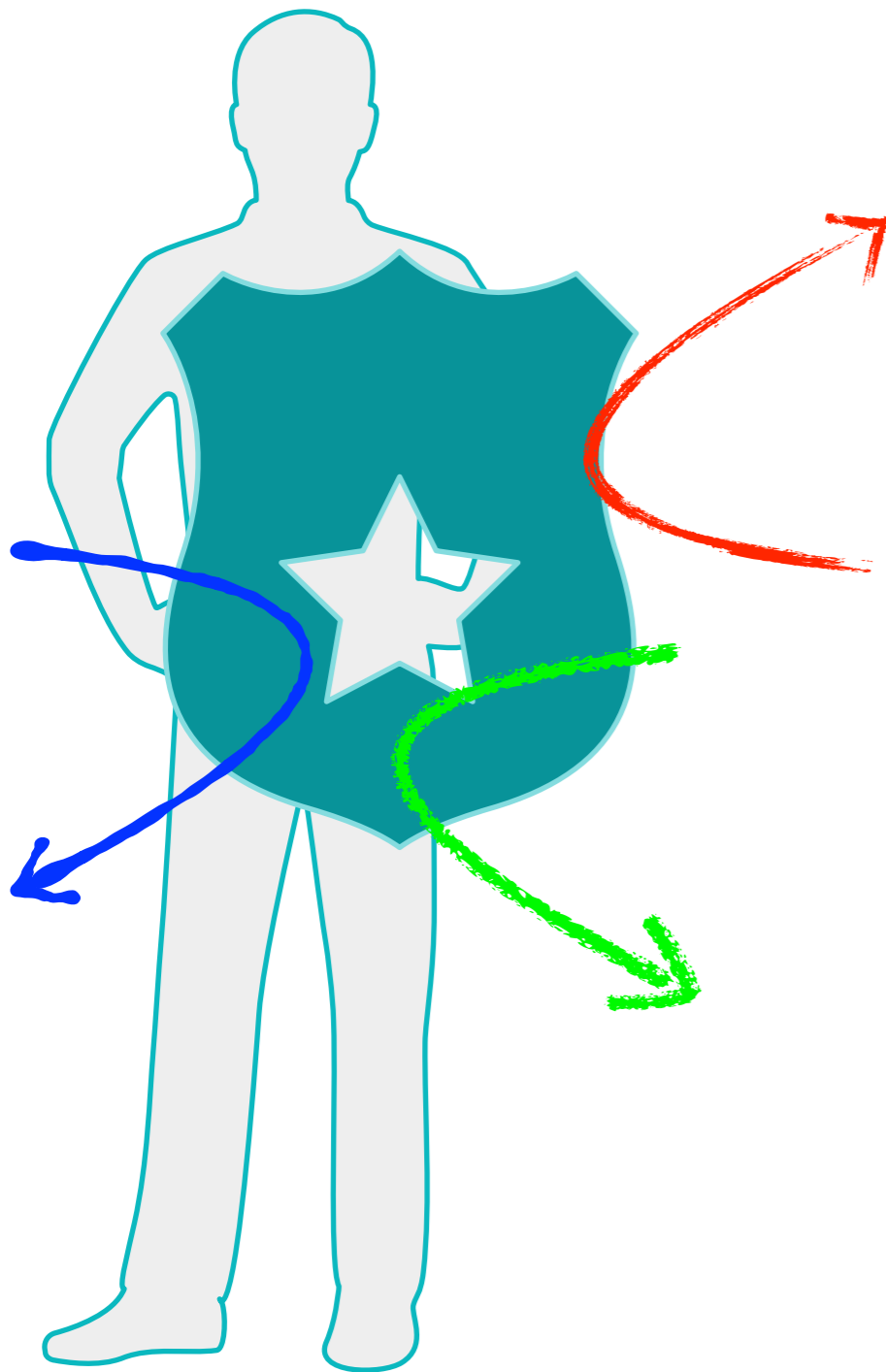


tiroidite



# Imunidade & Sistema imune

**Defesa da infecções e da alterações  
das próprias células**



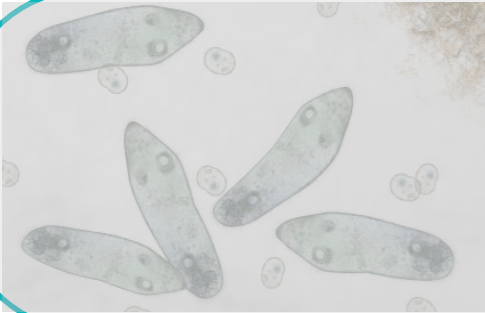
**sem prejudicar o hospedeiro**

Existem mecanismos de reconhecimento de moléculas próprias e moléculas ambientais que normalmente estão “desativados” ou “regulados”



# Imunidade & Sistema imune

## UNICELL



- **Receptores** → **sinalização intracelular**
- **Ambiente/genética modifica a resposta**

*Nearly all multicellular animals possess populations of cells in the fluid medium of the coelom or, in acoelomates, the mesoglea, for defence against potential microbial invaders*

## PLANTAS

- **Não existem células imunes**
- **Receptores**
- **Hormônios (sistêmico)**

## INVERTEBR

- **Existem algumas células imuno-like**
- **Associadas a intestino**
- **Receptores**
- **Fluido celomico (celomocitos)**
- **Hemolinfa (hemocitos)**
- **Mesoglea (amebocitos)**

## VERTEBR

- **Células imunes**
- **Tecidos especializados**
- **Receptores**
- **Linfa (sistêmico)**
- **Sistema adaptativo & memória imunológica**

# Sistema imune & Resposta Imune

1. Reconhecimento
2. Resposta
3. Eliminação da origem do dano
4. Volta a normalidade (homeostasia)

Indipendentemente da complexidade do sistema imune sempre são presentes essas etapas



# Sistema imune

Órgãos, tecidos e células especializados interconectados

## **Células imunes (leucocitos)**

- circulantes (sangue, linfa)
- teciduais (residentes)

## **Órgãos e tecidos linfáticos**

**Moléculas solúveis (imunidade humoral; comunicação entre as partes)**

# Células inmunes (Leucocitos) vertebrados

Células Mieloides

*Polimorfonucleados Granulocitos*



**Neutrofilos**



**Basofilos**



**Eosinofilos**



**Mastocitos**



**Monocitos**

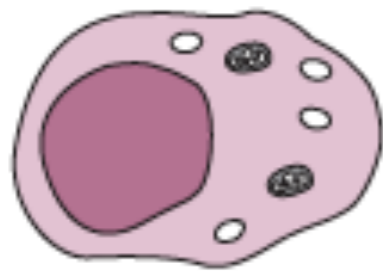


**Macrofagos**



**Células Dendriticas**

Linfocitos



**Natural Killer**



**Linfocitos T**



**Linfocitos B**

# Células imunes invertebrados

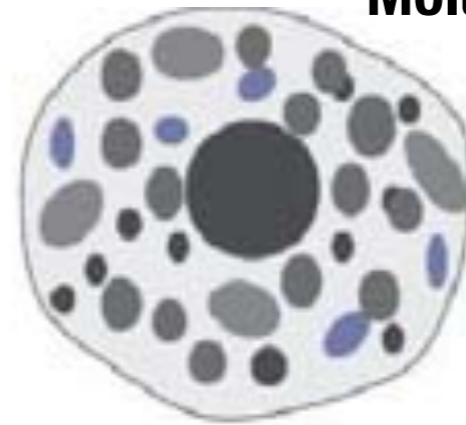
**Artropodes**



immature cell present in the circulation of decapod crustaceans and insects



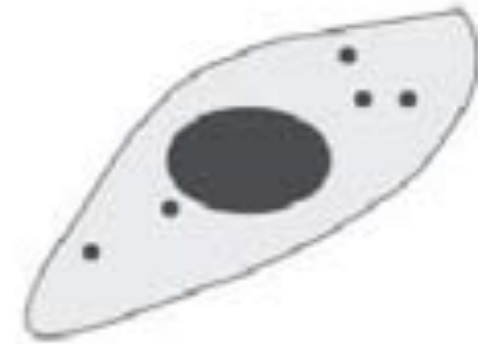
plasmatocytes



Mature cells

**Moluscos**

**Artropodes**

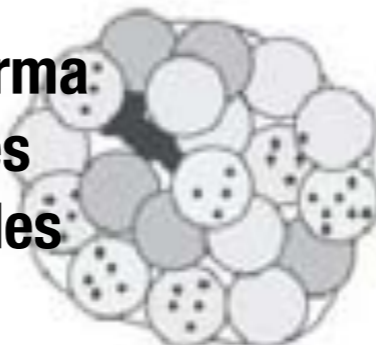


Haemocyte (fagocito)



Haemocyte (fagocito)

**Equinoderma  
Anelides  
Artropodes**



Haemocyte (fagocito)



oenocytoids

**Insetos**



oenocytoids

**Equinoderma**

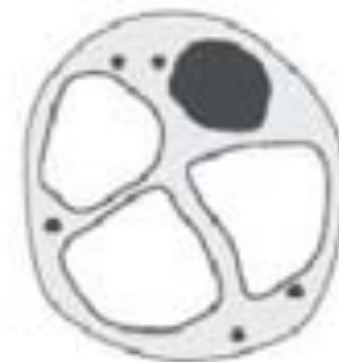


motile cell  
(clotting)



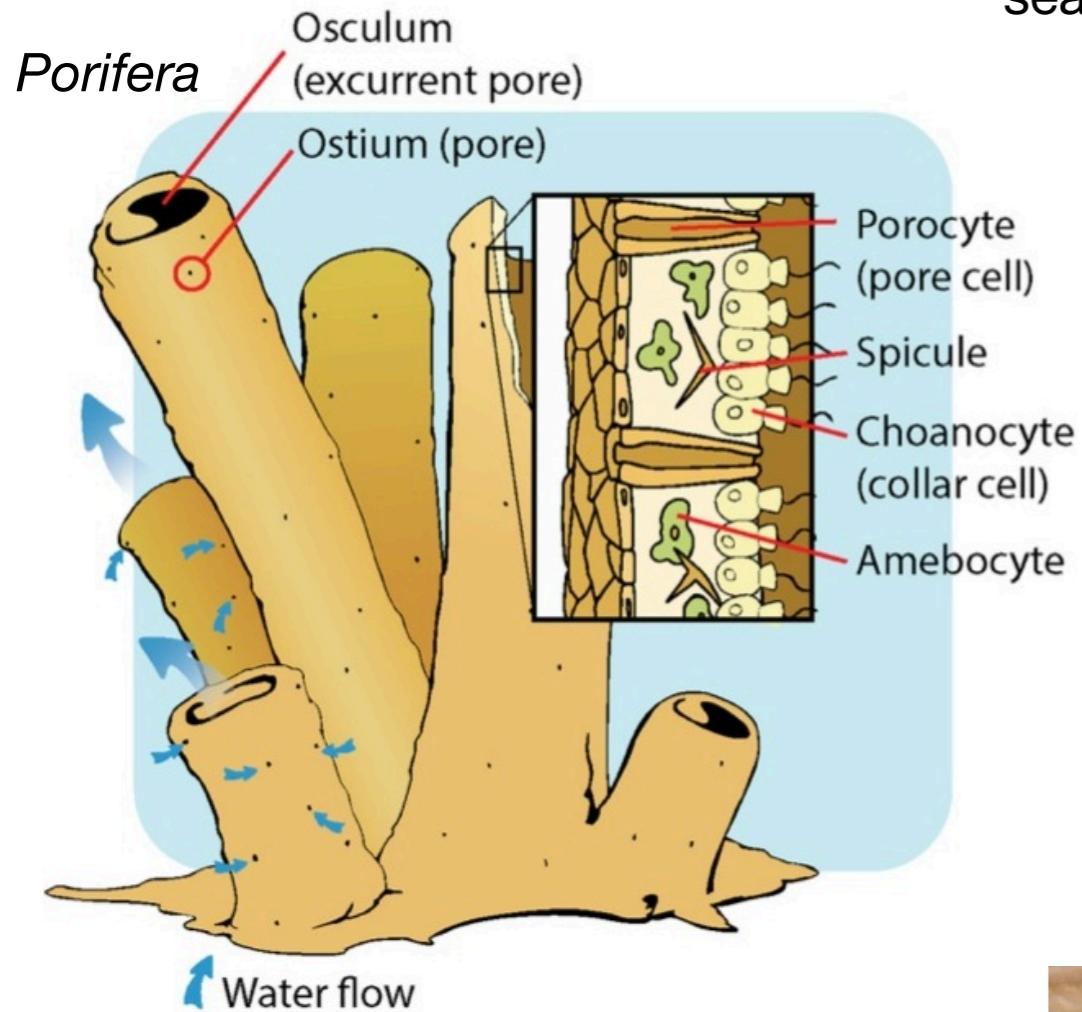
coelomocyte

**Ascidian**

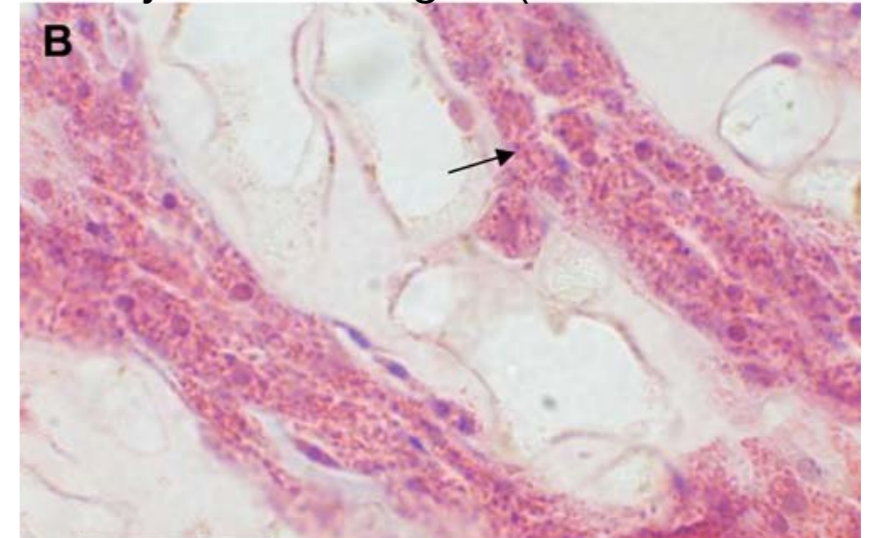
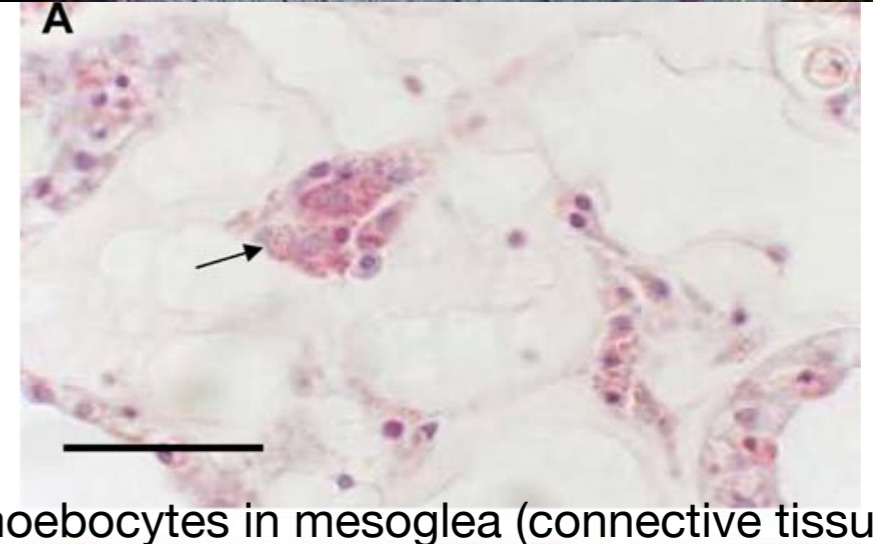


# Células imunes invertebrados

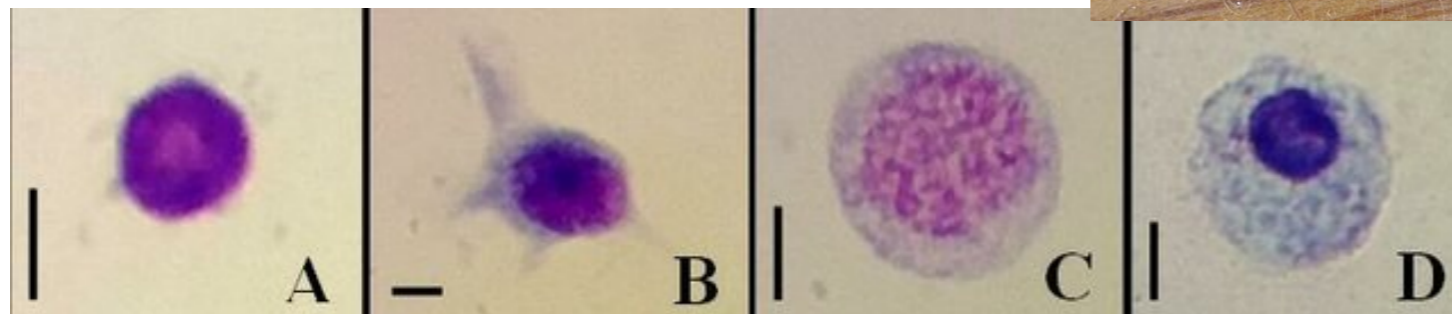
sea fan coral (*Gorgonia ventalina*) infected with *Aspergillus sydowii*



*Cnidaria*



Circulating hemocytes in adults of *H. rufipes*



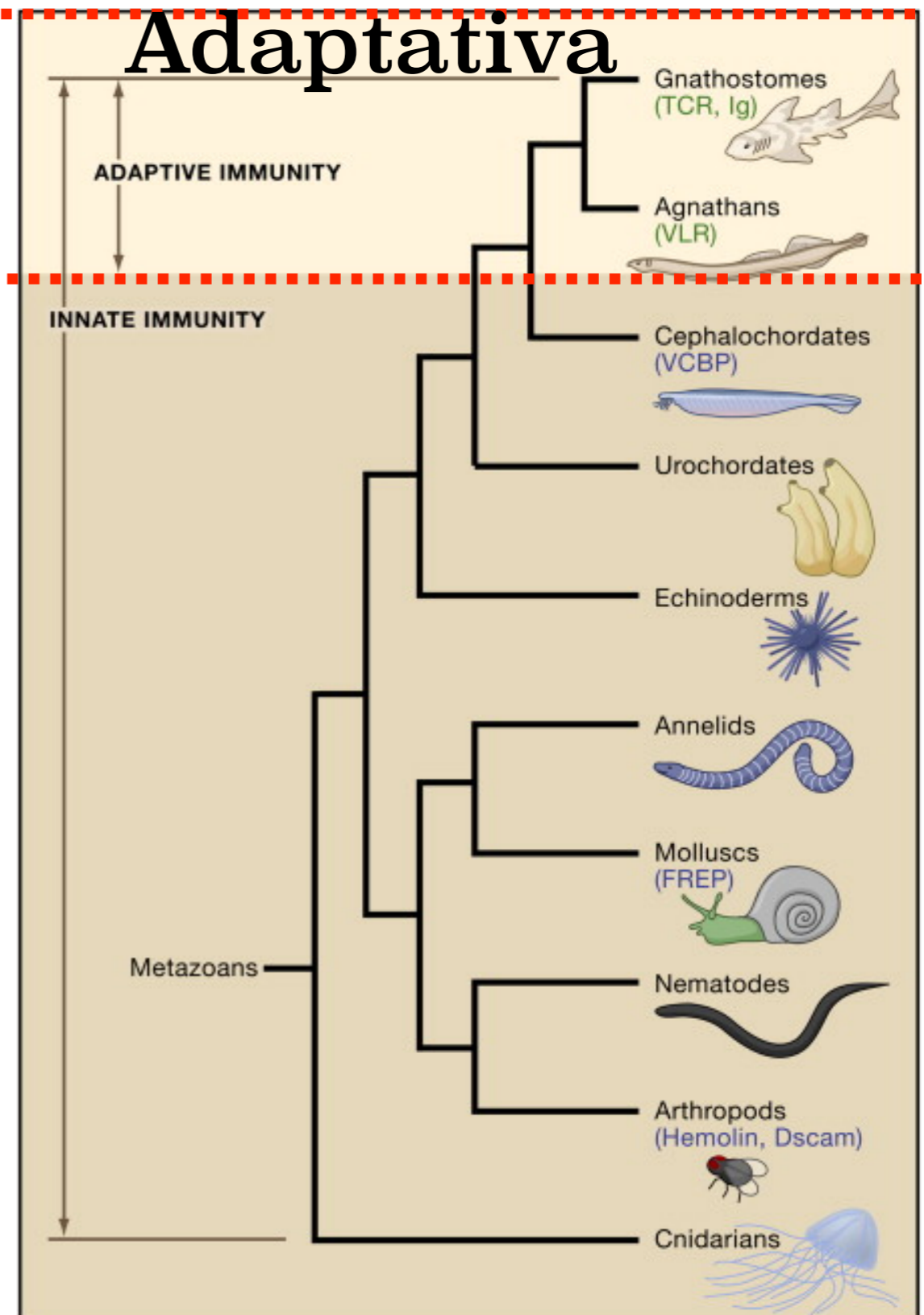
(A) Prohemocyte. (B) Plasmatocyte. (C) Granular cell. (D) Oenocytoid. Scale bar: 5  $\mu$ m

# Sistema imune “inato” e “adaptativo”

- **CELULAR:** Linfocitos
- **HUMORAL:** Anticorpos

## Inata

- **CELULAR:** Células (mieloides, NK)
- **HUMORAL:** Sistema complemento



# Resposta Imune

*vertebrados*



## Inata

- 1ª linha de defesa
- receptores codificados por um numero *limitado* de genes (reconhecimento de *padrões*)
- dirigida contra estruturas compartilhadas (*padrões*)
- resposta rapida
- evolutivamente "antiga"

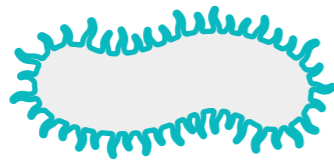
## Adaptativa

- 2ª linha de defesa
- receptores capazes de reconhecer milhões de peptídeos específicos (originados por recombinação somática do DNA)
- dirigida contra antígenos específicos
- resposta "retardada"
- memoria imunologica
- evolutivamente "nova" (vertebrados)

# Patógenos & Resposta Imune



8-72 horas



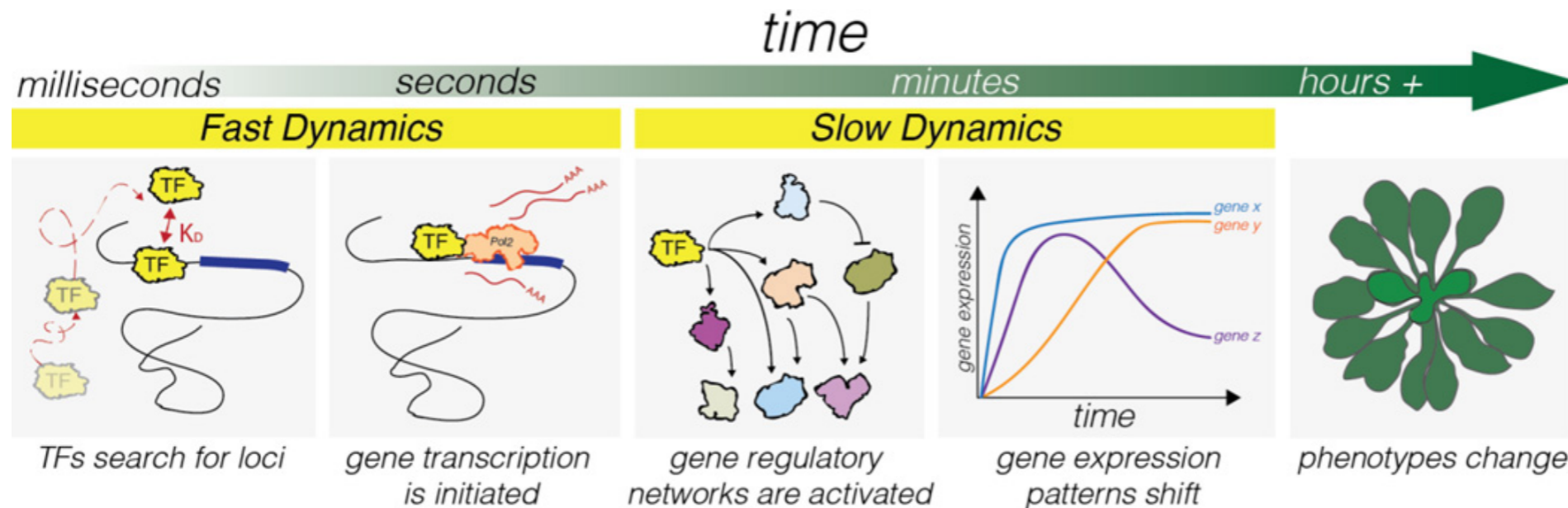
min (20 *E coli*)  
horas (15 *M tuberculosis*)



E uma questão de tempo!

Average *gene transcription* & *protein synthesis* time.

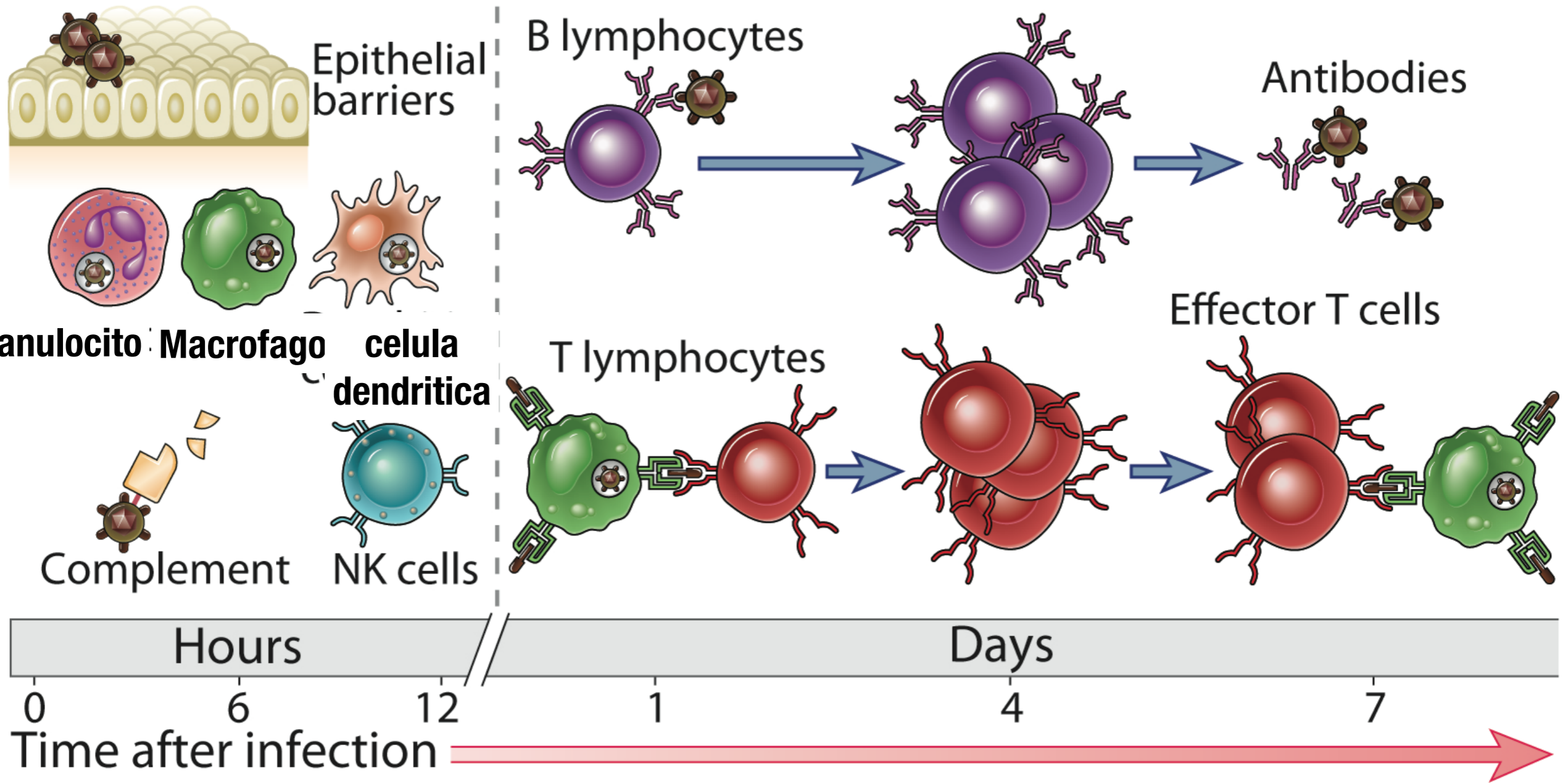
- Prokaryotes (~1 min; ~6 sec).
- Eukaryotes (~ 10 min ~2 min).



# Resposta Imune

Inata

Adaptativa





# Sistema imune

Órgãos, tecidos e células  
especializados interconectados

## Órgãos linfóides (OL)

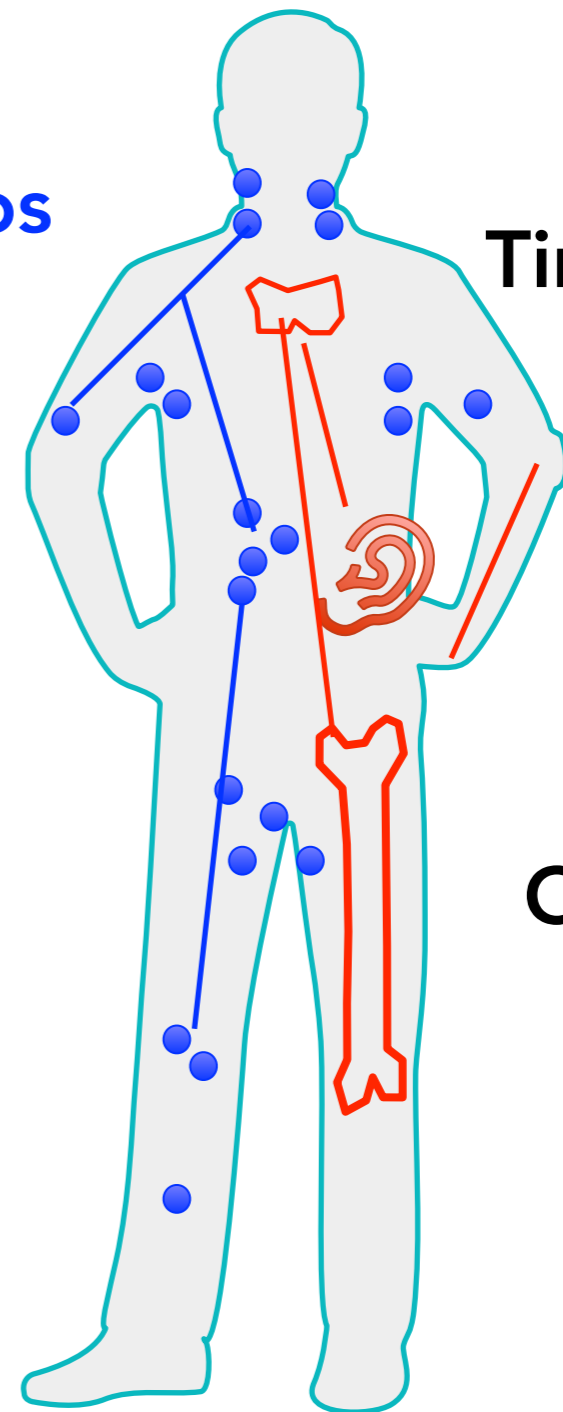
- primarios (MO e Timo)
- secundarios (Linfonodos, Baço)

Linfonodos  
(LN)

Timo

Baço

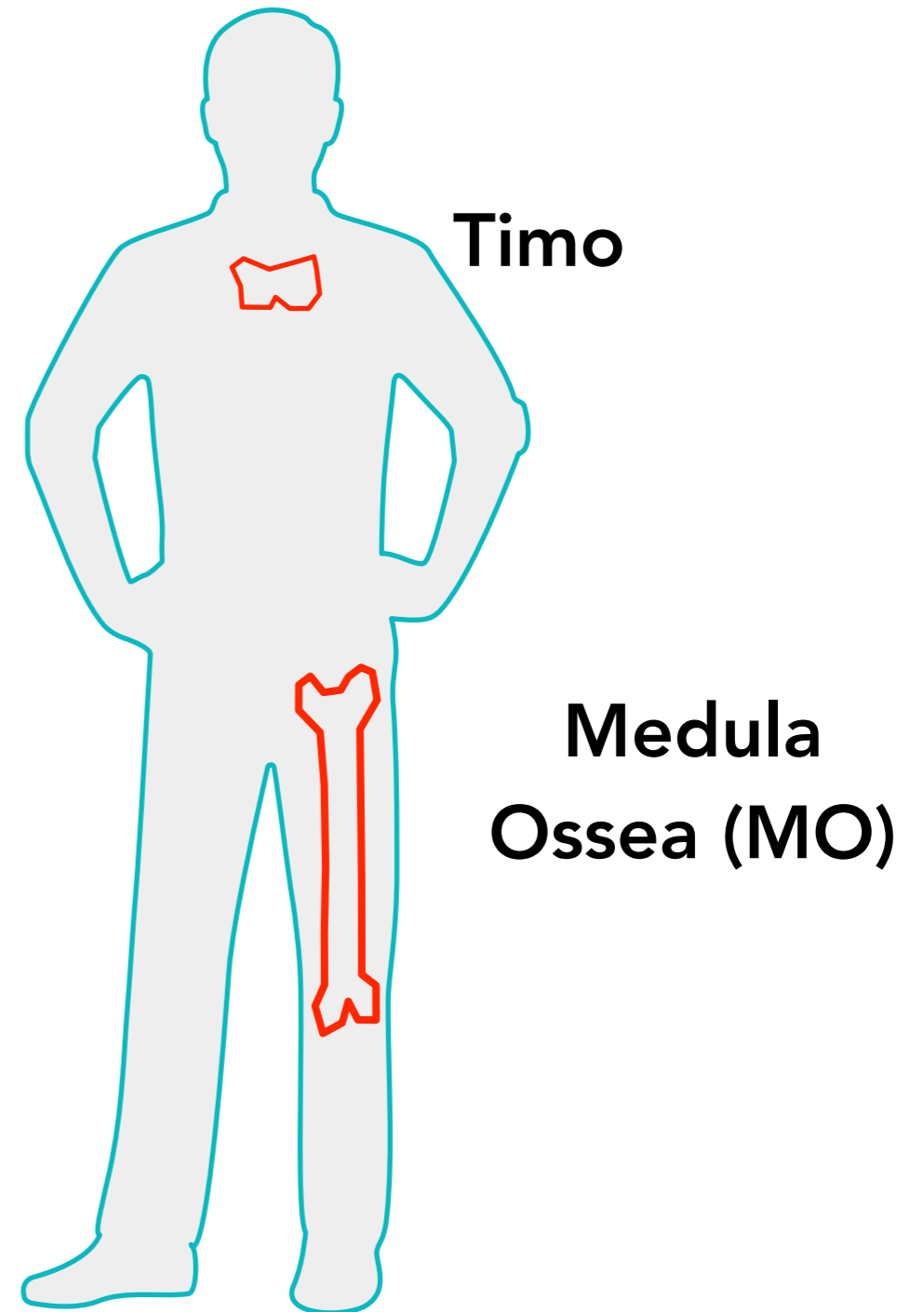
Medula  
Ossea (MO)



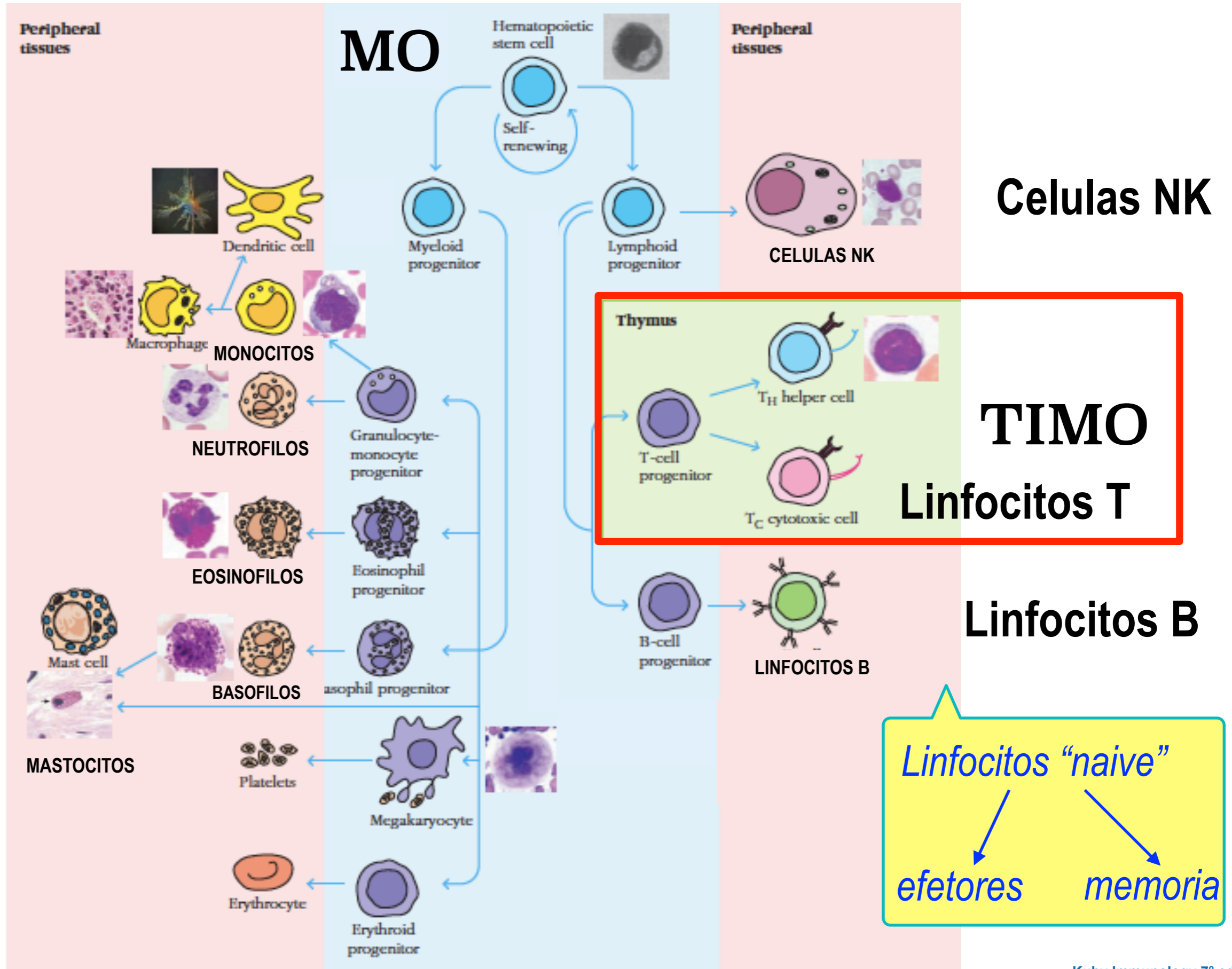
# Órgãos linfóides primários & Hematopoiese

Processo de formação das células sanguíneas, incluindo os **leucócitos**

Acontece nos **Órgãos Linfóides Primários**

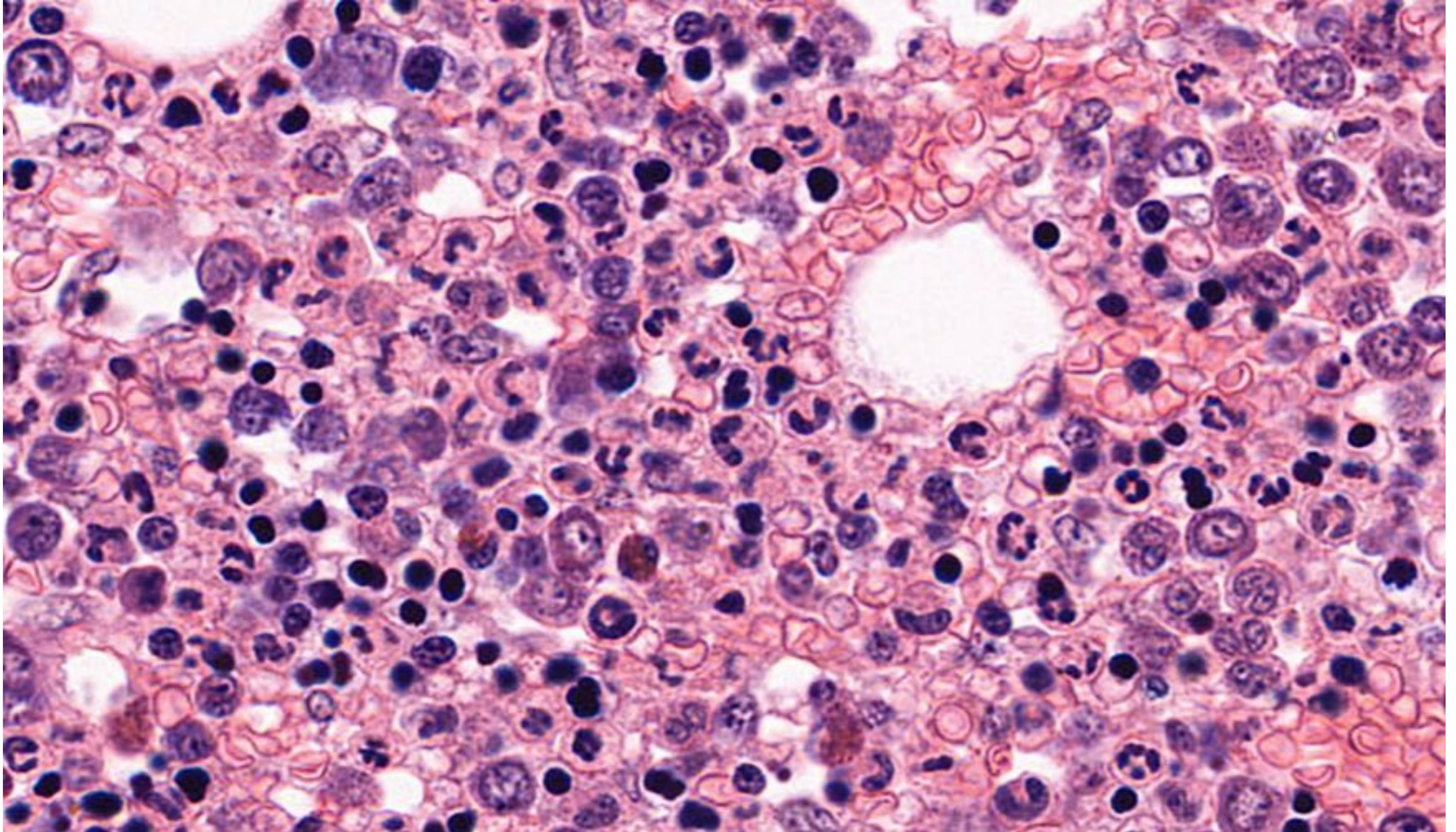


# Hematopoiesis

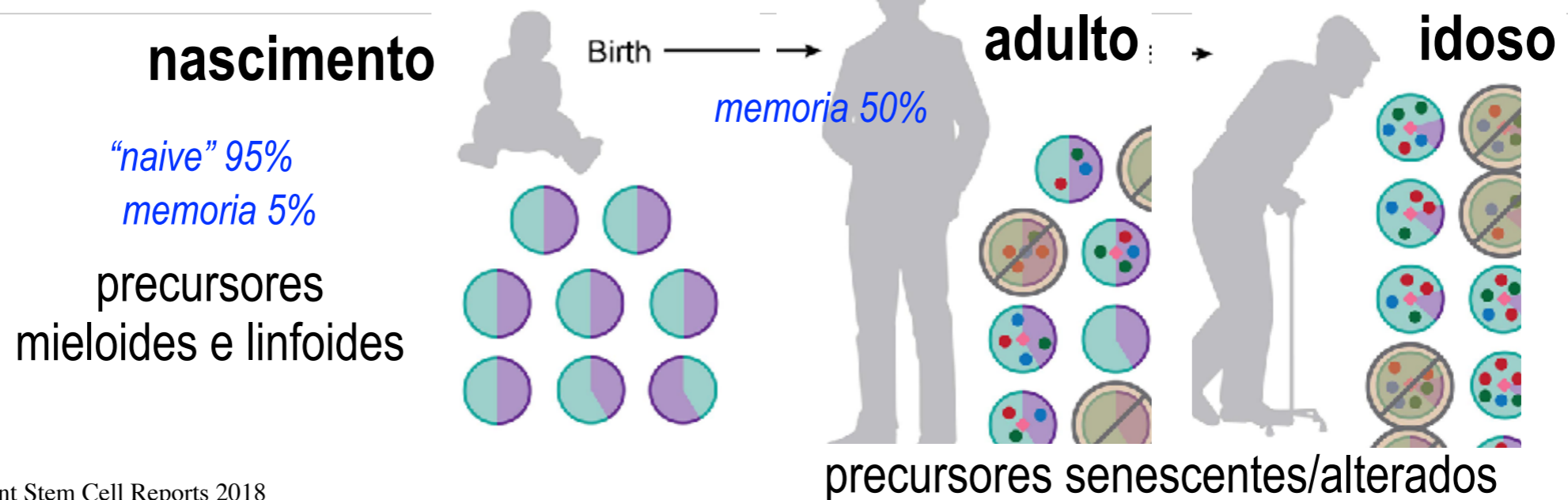
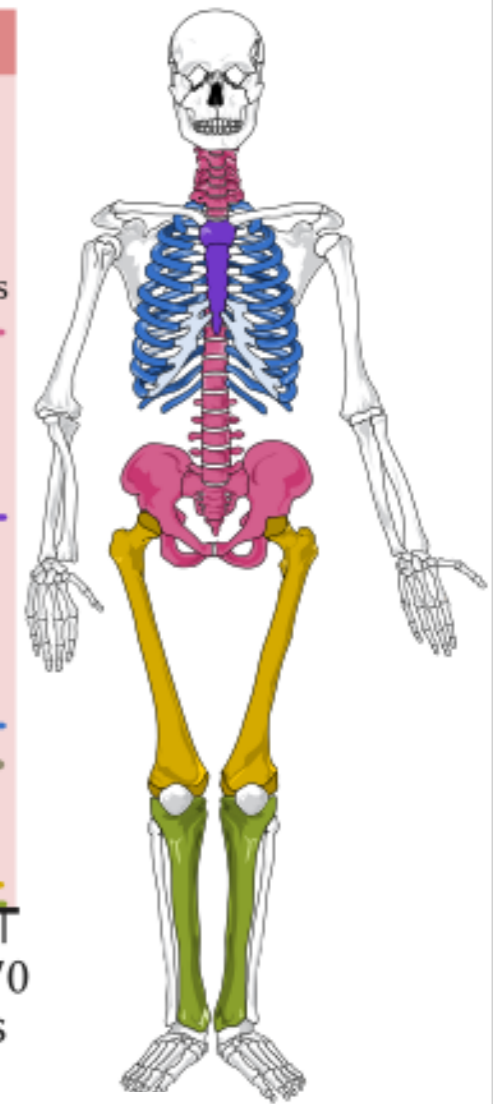
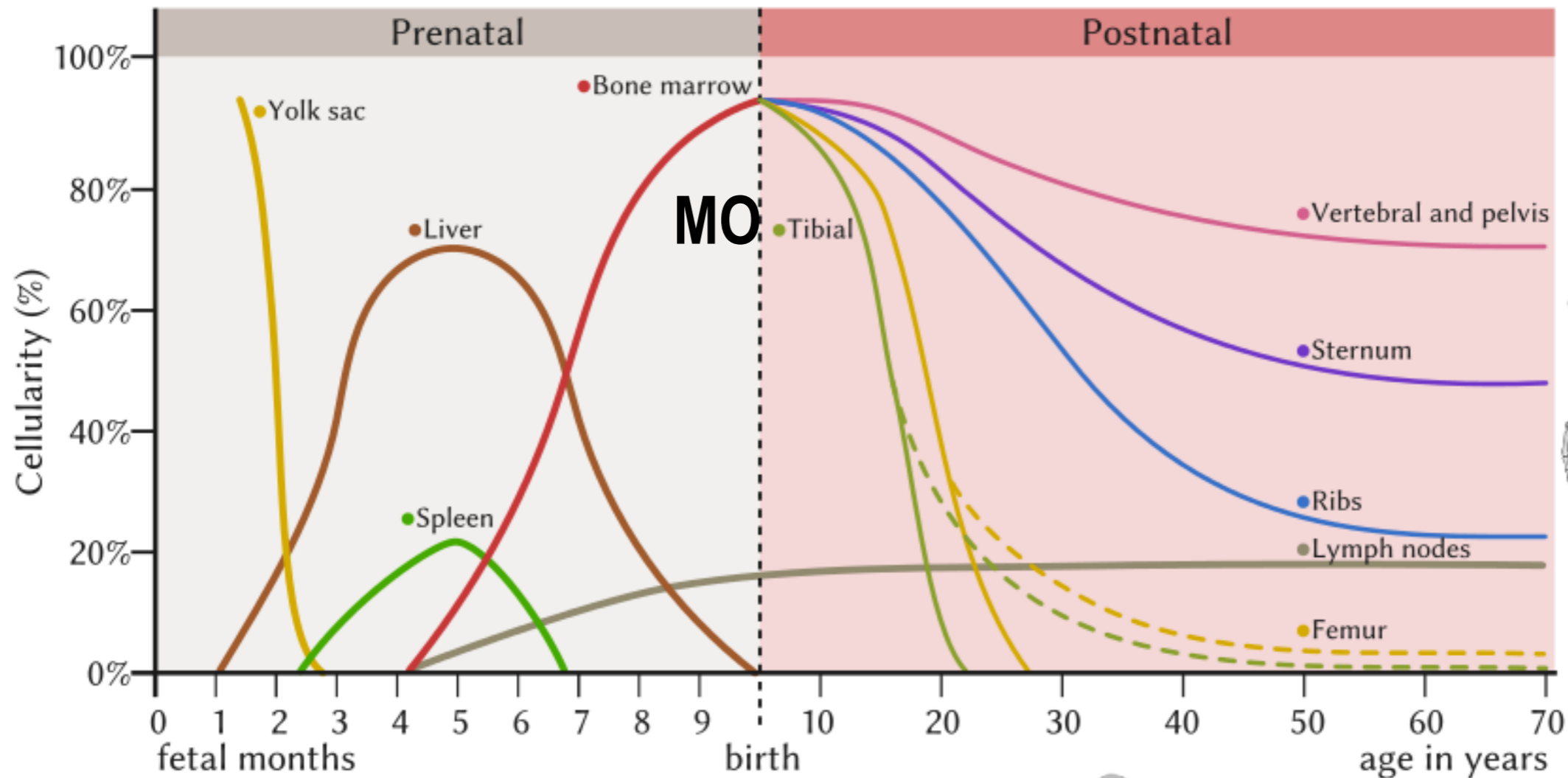


# Medula Ossea

## HEMATOPOIESE



# Hematopoiese



# Hematopoiese & Destino

**MO**

celula tronco  
hematopoietica

progenitor  
mieloide

progenitor  
linfoide

**Sangue**

pro-T

monocito

neutrofilo

eosinofilo

basofilo

linfocito  
NK  
5-15%

linfocito T

linfocito B

**T. periféricos**

macrofagos

mastocito

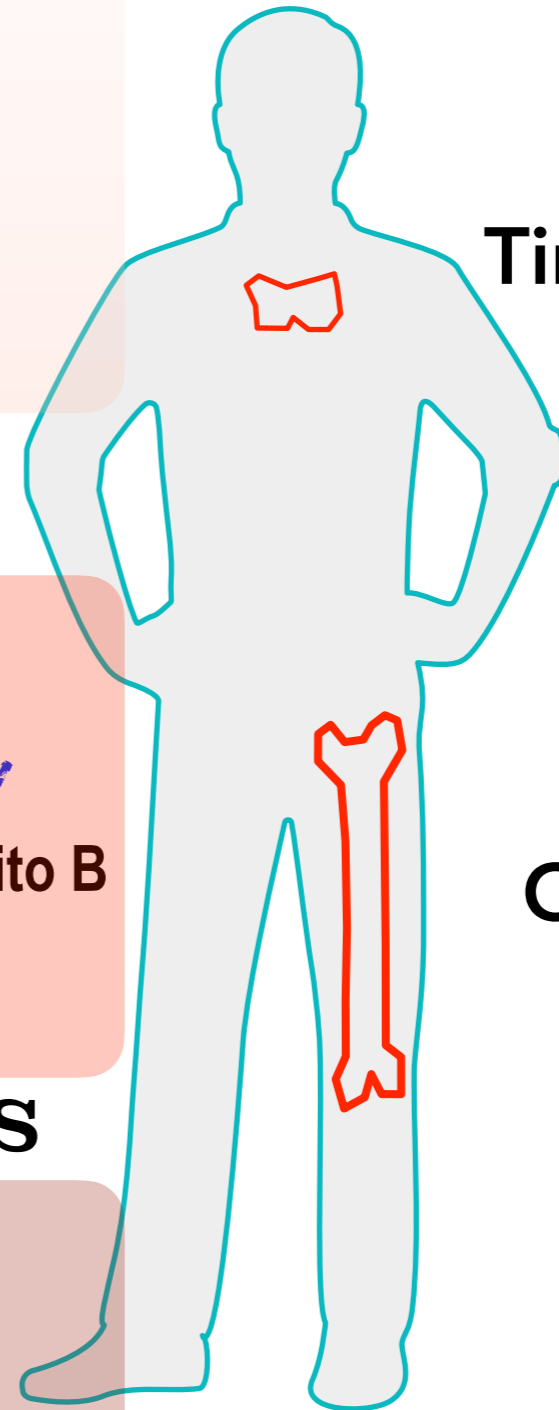
celula dendritica

linfocitos

**OL secundarios**

**Timo**

**Medula  
Ossea (MO)**



# Leucocitos sanguíneos

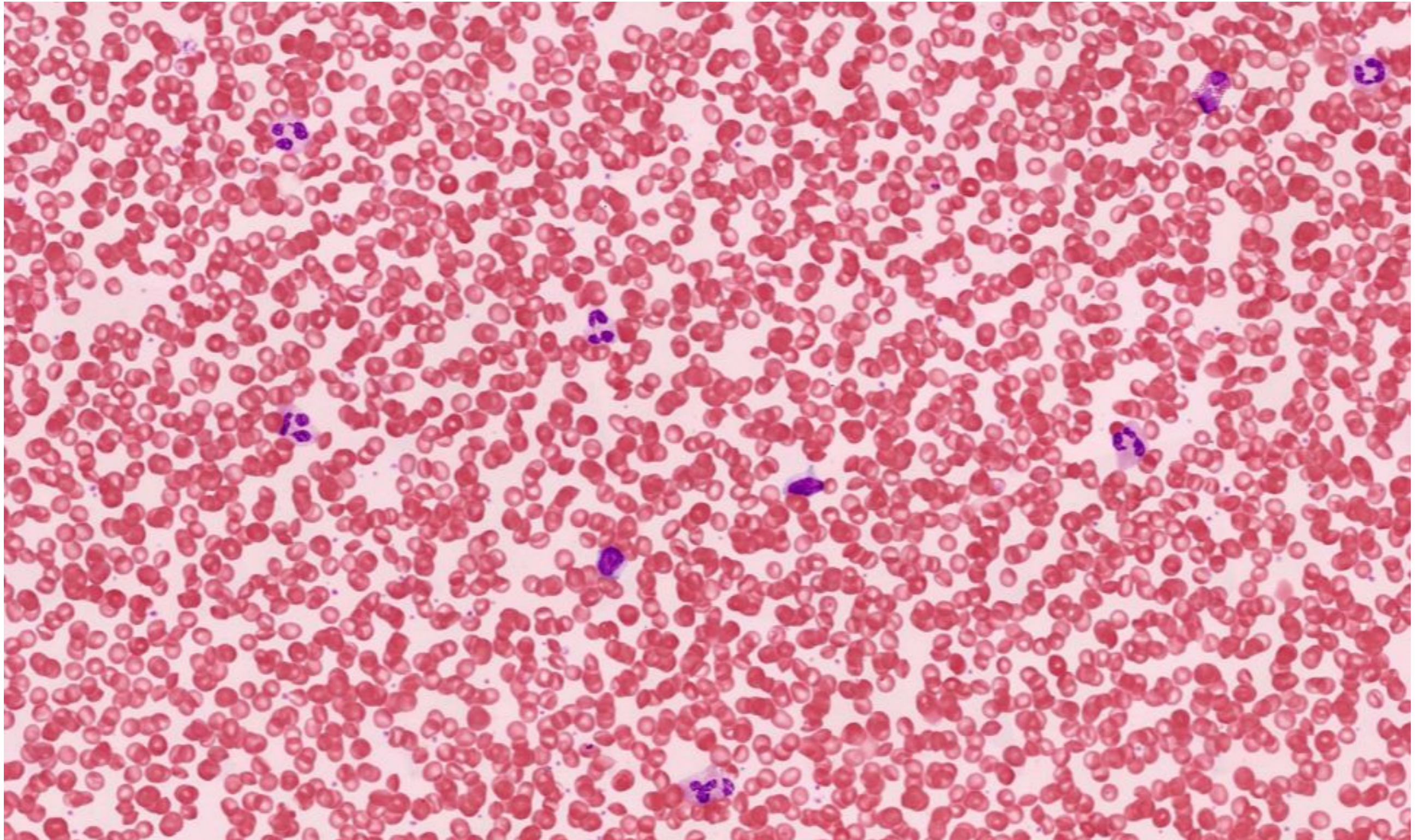
Leucometria global:

-4000 a 11000 células/mm<sup>3</sup>



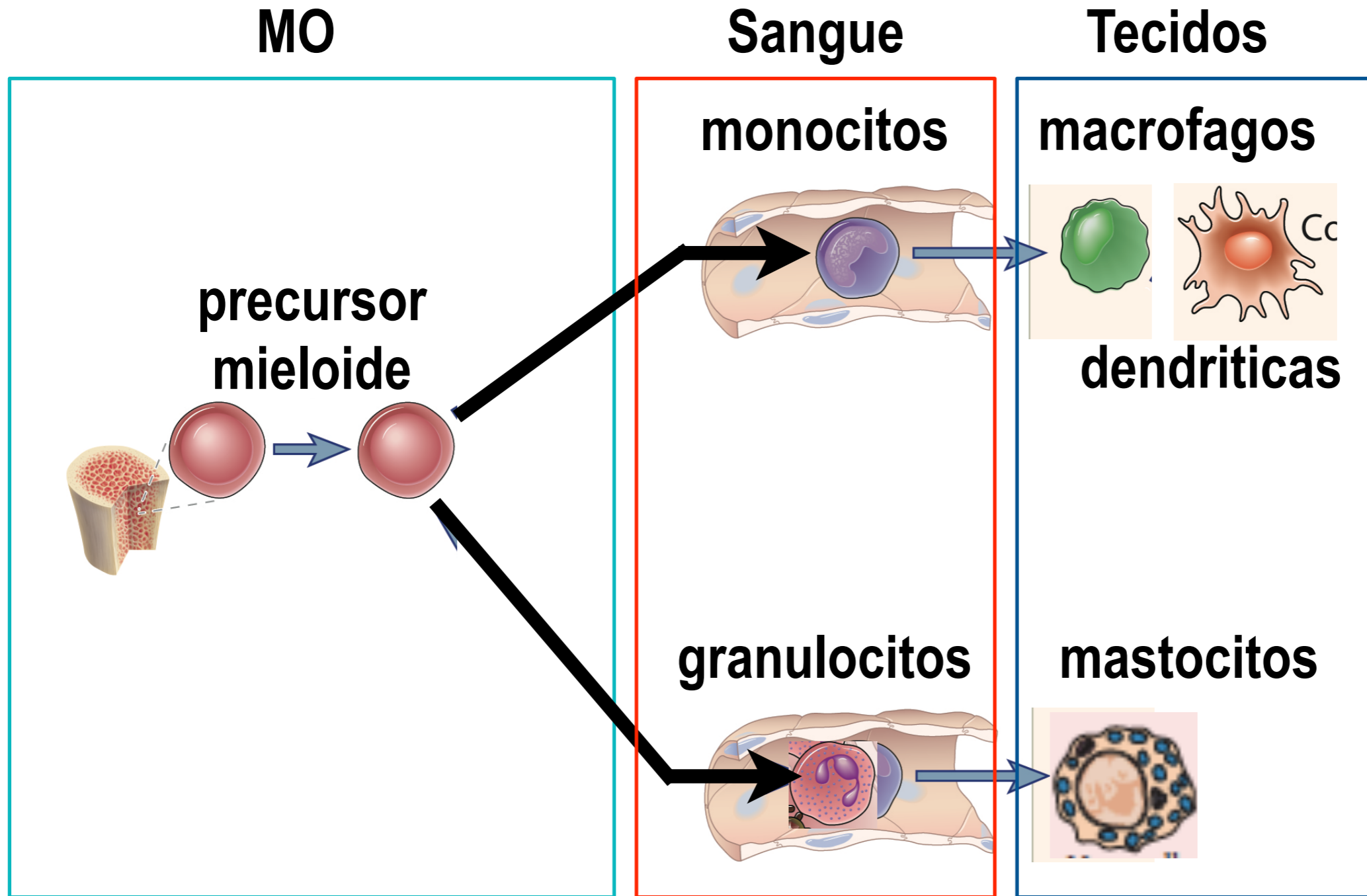
Cell type	Cells/mm <sup>3</sup>	Total leukocytes (%)	Tempo de vida
Red blood cells	$5.0 \times 10^6$		
Platelets	$2.5 \times 10^5$		
Leukocytes	$7.3 \times 10^3$		
Neutrophil	$3.7-5.1 \times 10^3$	50-70	6 horas no sangue, alguns dias baço/tecido
Lymphocyte	$1.5-3.0 \times 10^3$	20-40	Semanas; Anos para células de memória (T, B)
Monocyte	$1-4.4 \times 10^2$	1-6	Horas/dias no sangue
Eosinophil	$1-2.2 \times 10^2$	1-3	4-5 horas no sangue, 8-12 dias tecido
Basophil	$<1.3 \times 10^2$	<1	Algumas horas/dias

# Leucocitos sanguíneos





# Células mieloides



# Linfocitos

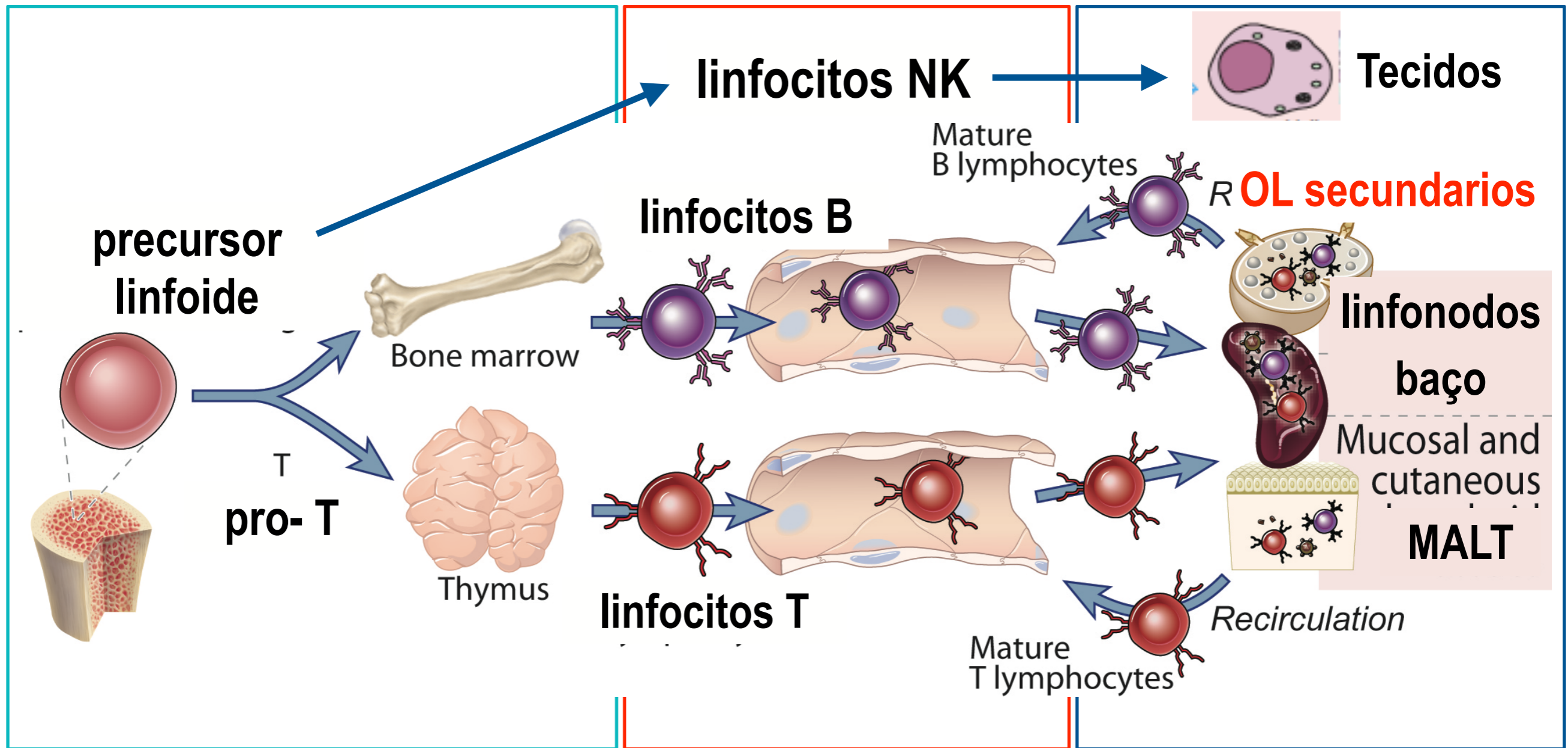
4% pele  
15% GALT  
65% OL 2

10% MO/Timo

Sangue 2%

Tecidos

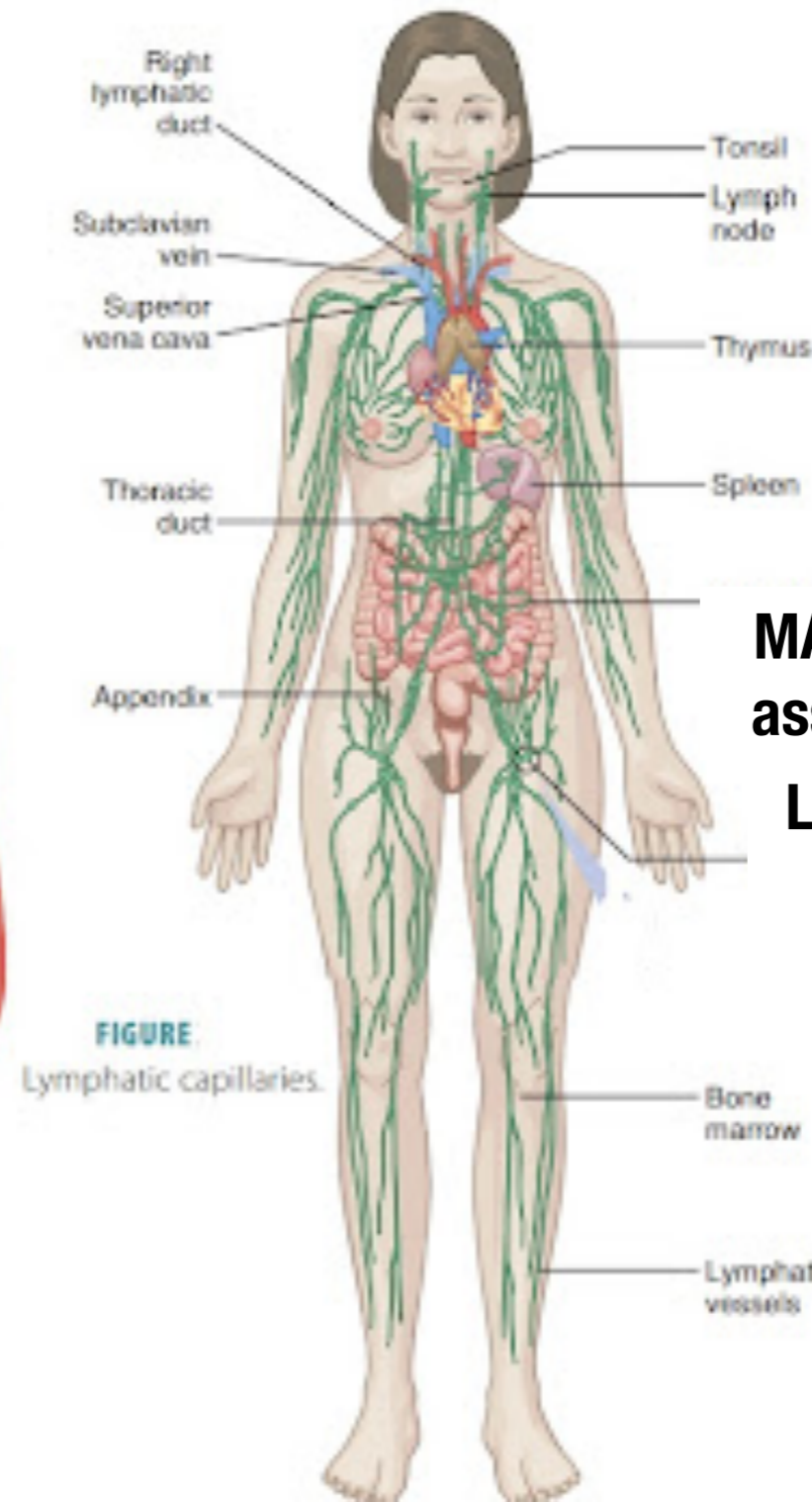
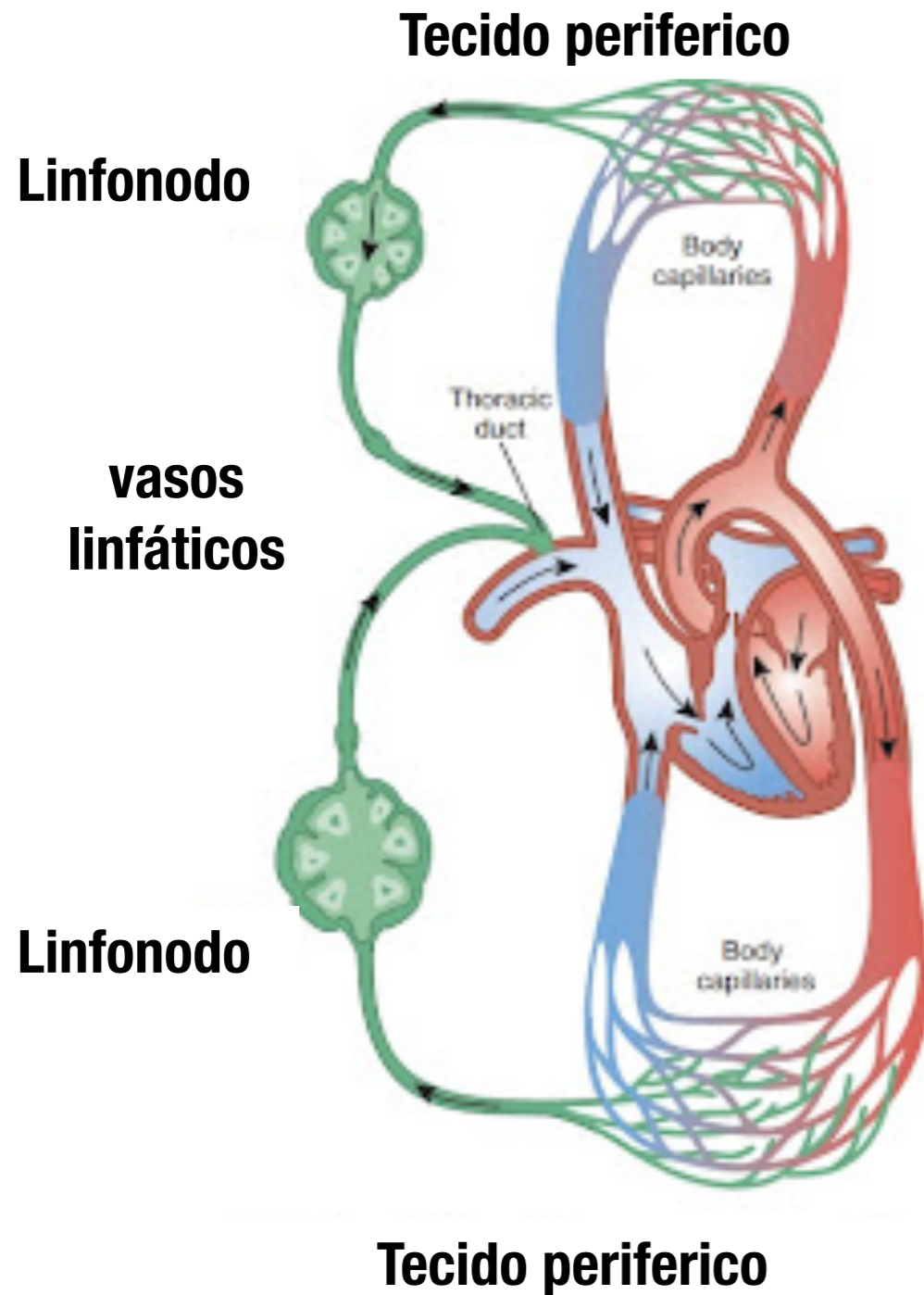
65% OL 2



**Recirculação dos linfócitos B e T**

# Sistema linfatico vs sanguineo

## DRENAGEM DOS TECIDOS PERIFERICOS e RECIRCULACAO



Tonsilas

Linfonodos cervicais

Linfonodos mesentericos

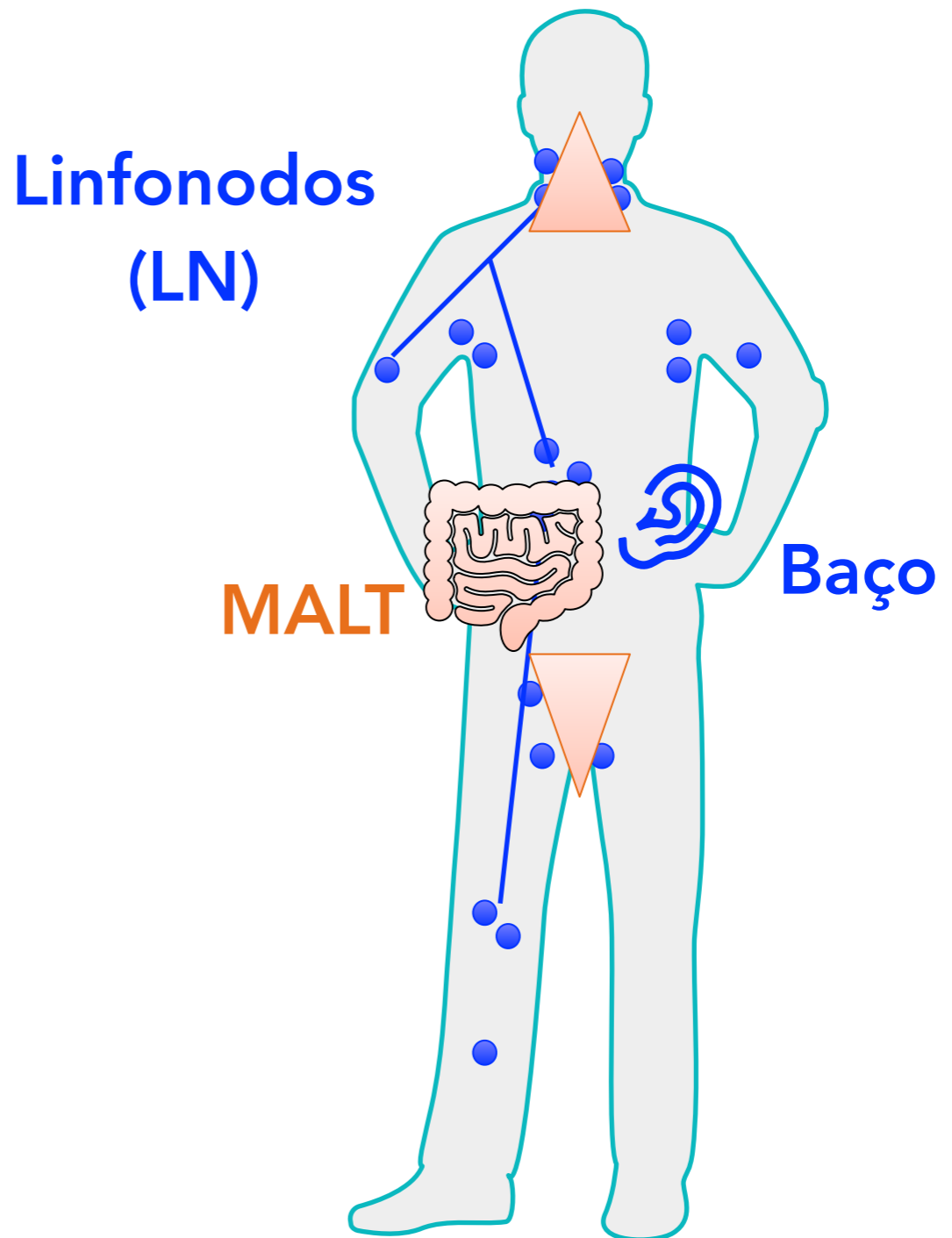
MALT (tecido linfoide associado a mucosa)

Linfonodos pelvicos

FIGURE  
Lymphatic capillaries.

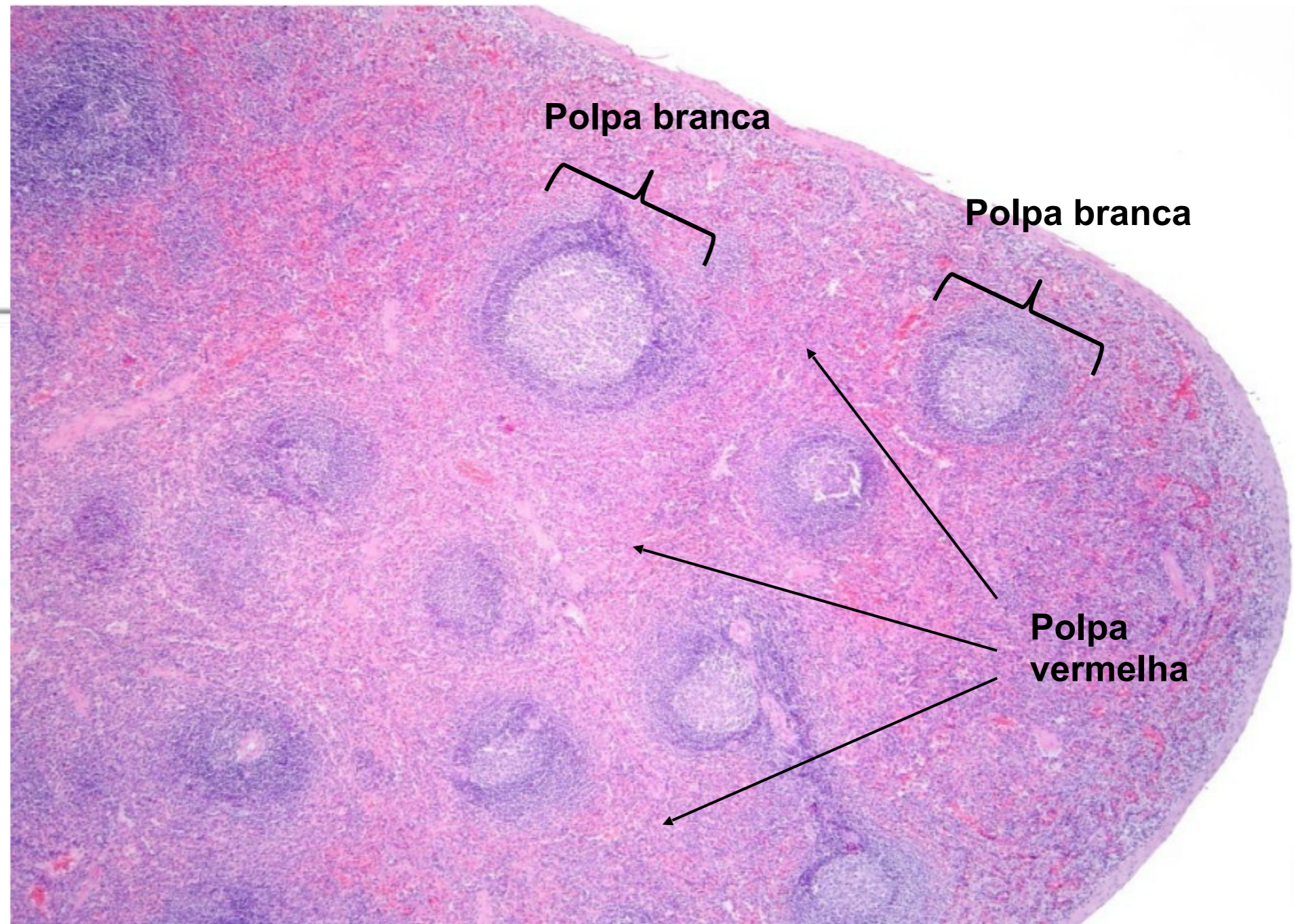
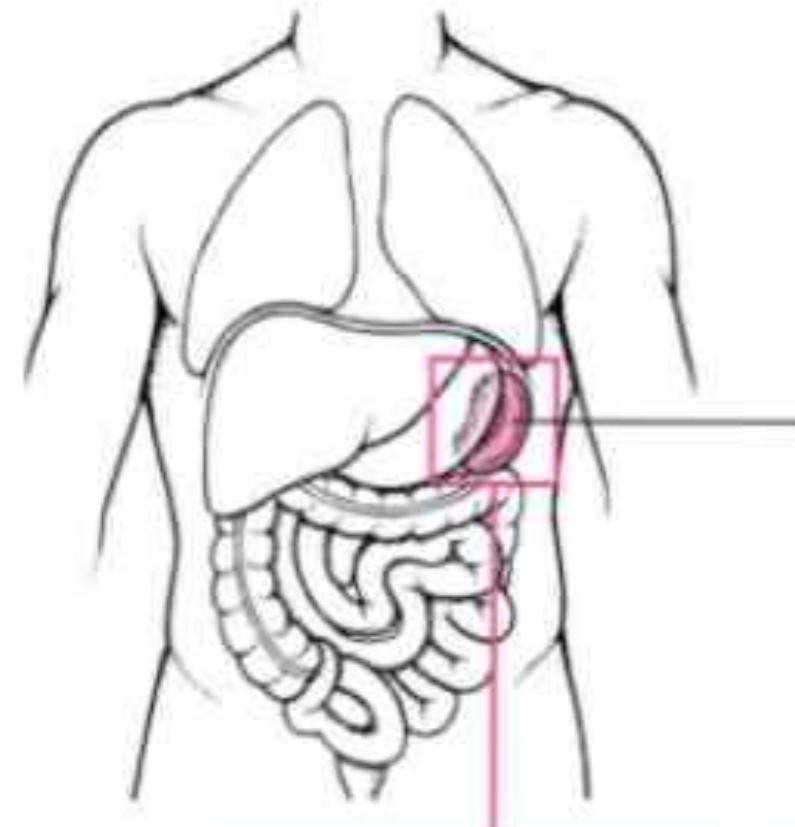
# Órgãos linfóides secundários e MALT

Locais de ativação dos linfócitos T e B



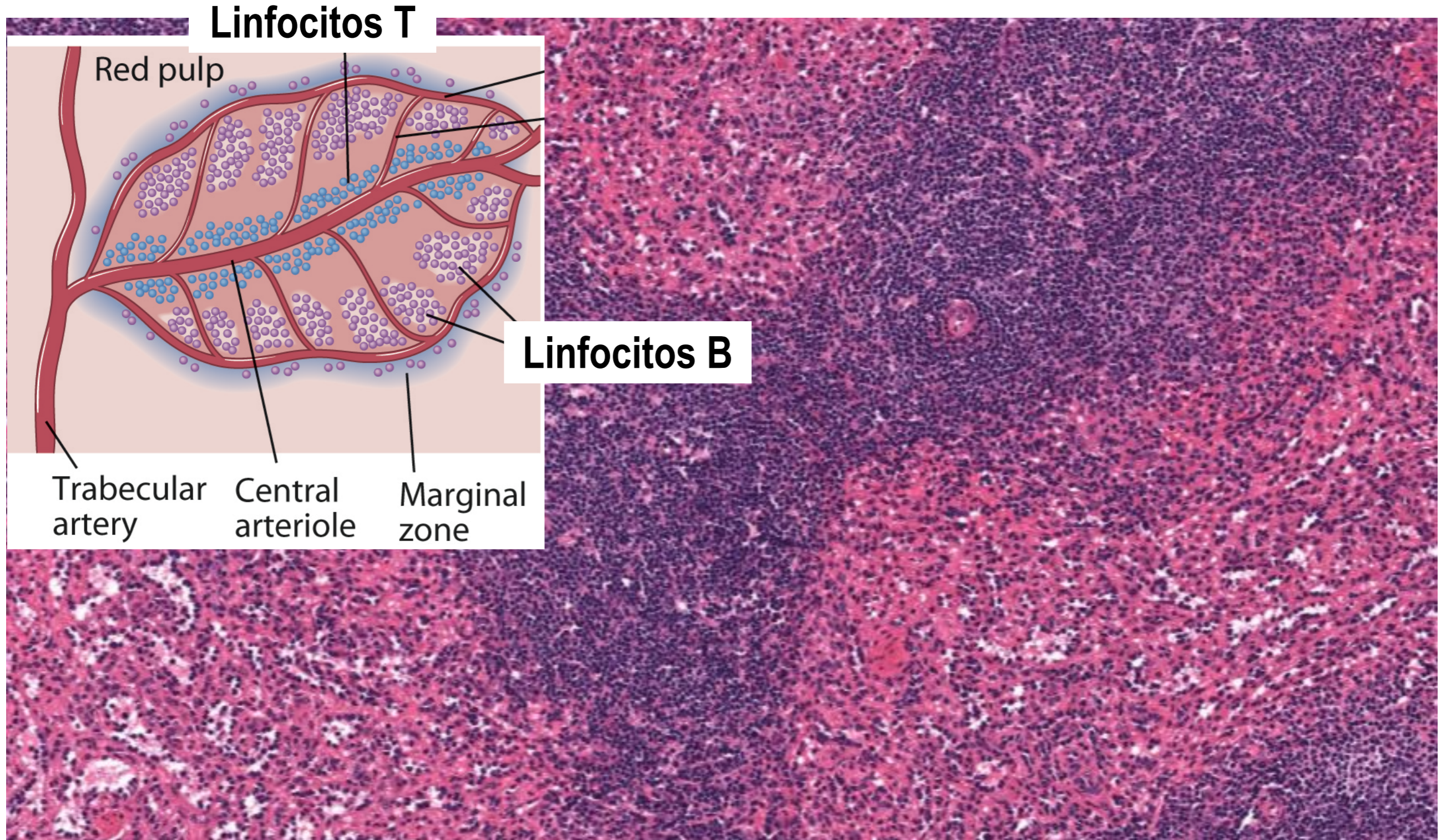
# Baço

## ATIVACAO LINFOCITOS T e B



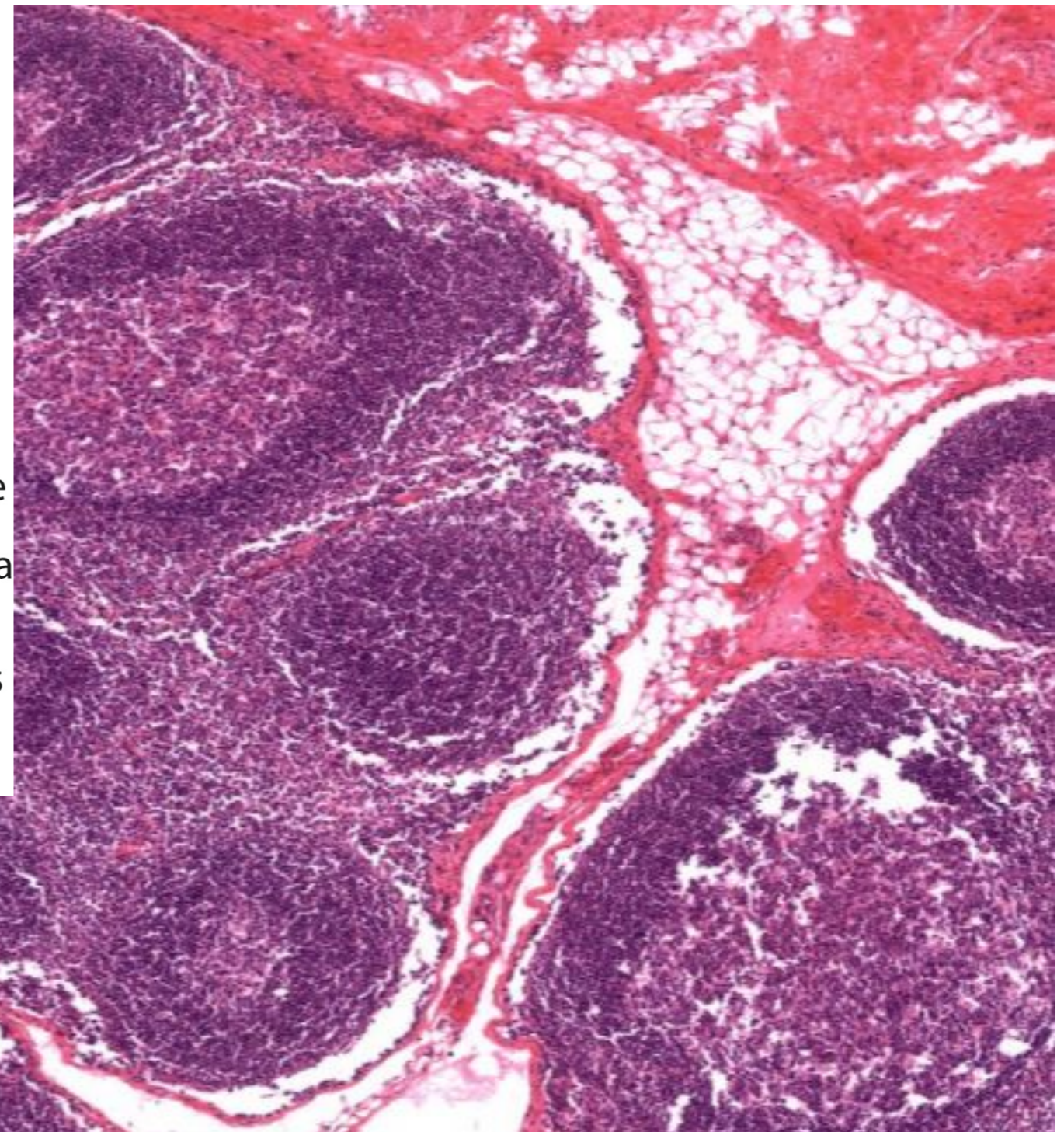
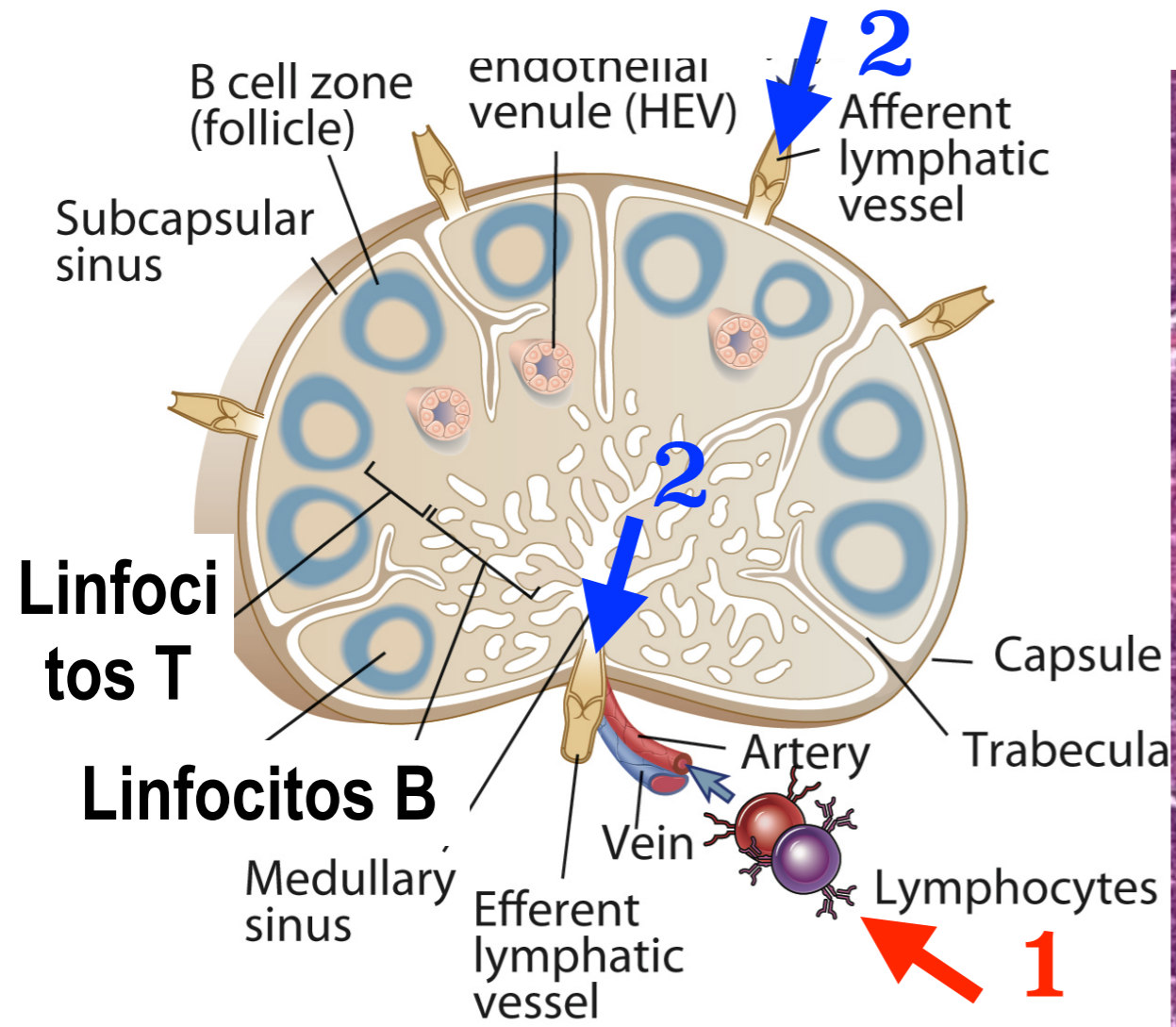
# Baço

## ATIVACAO LINFOCITOS T e B

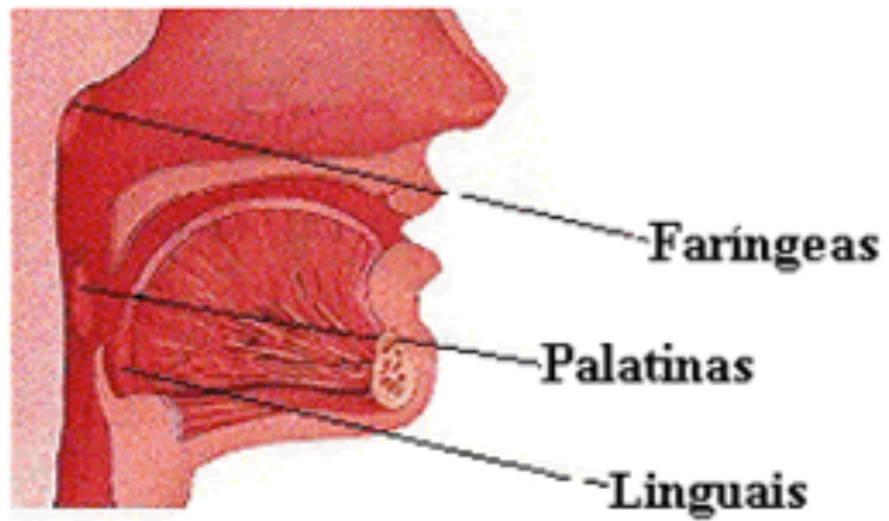


# Linfonodo

## ATIVACAO LINFOCITOS T e B

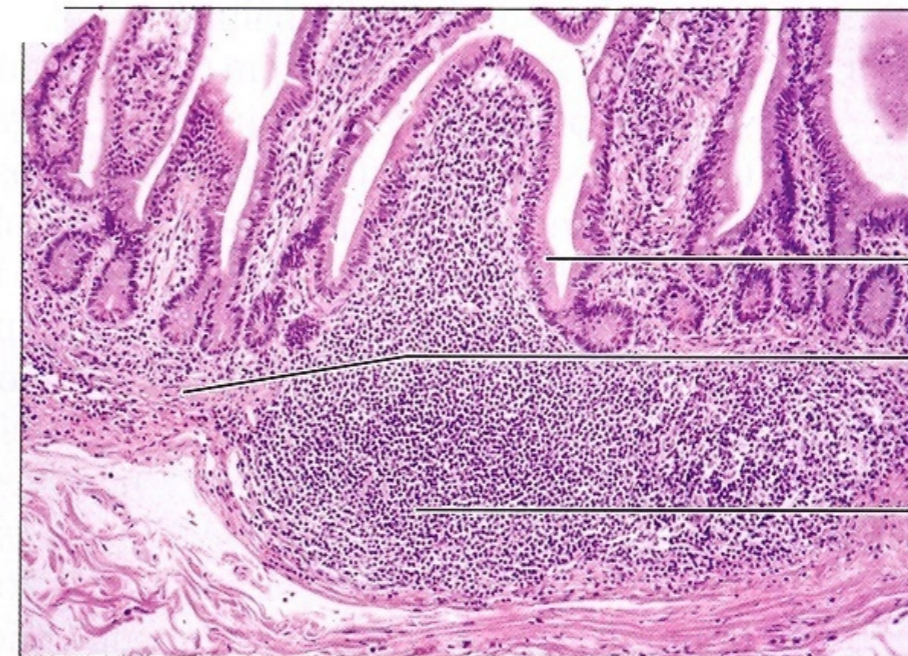
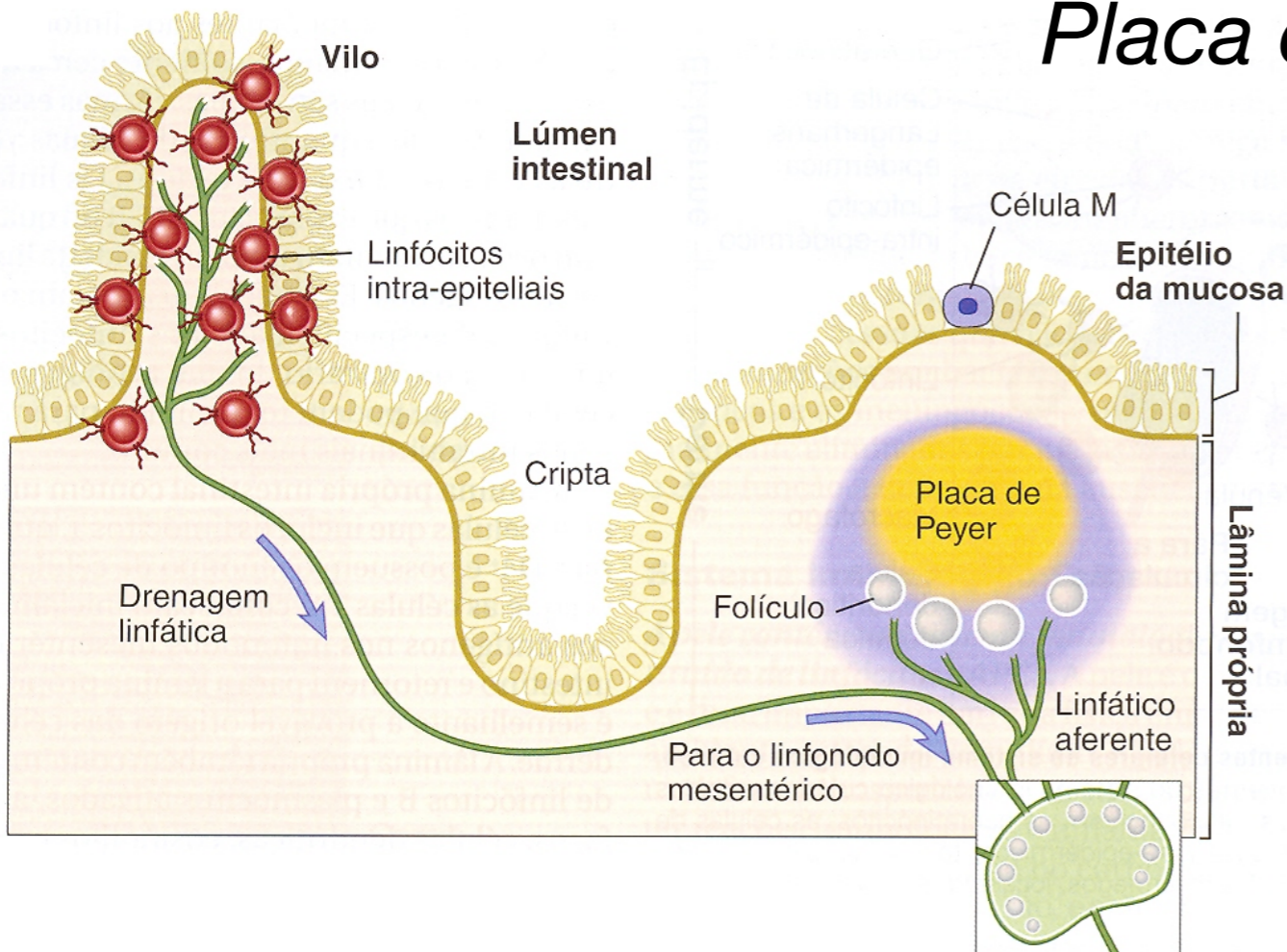


# Tecido Linfoide associado a Mucosa (MALT)



*Tonsilas ou Amígdalas*

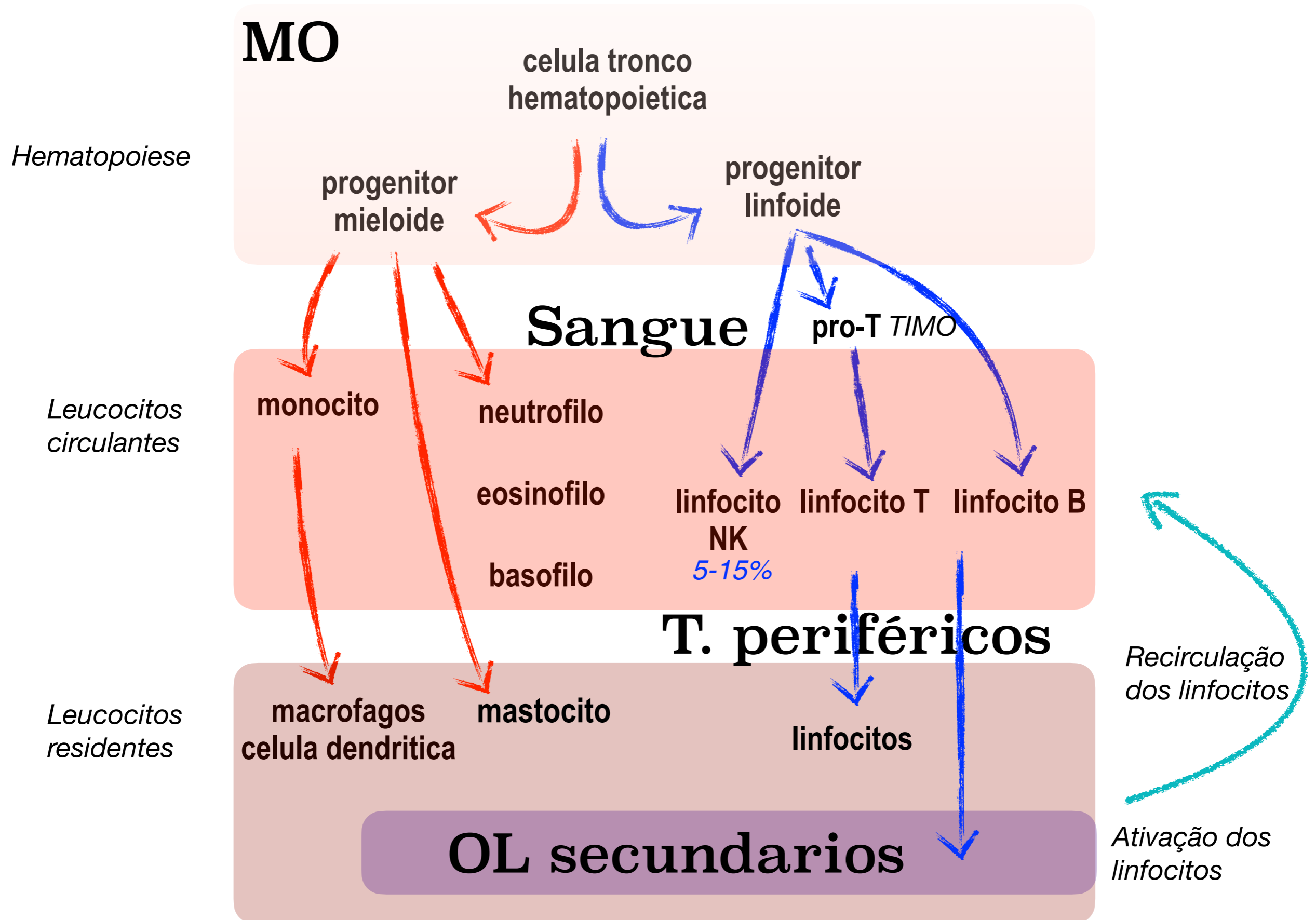
*Placa de Peyer*



Epitélio mucoso  
Lâmina própria  
Placa de Peyer



# Leucocitos & Localização



# Tópicos Essenciais da Aula

1. *Conhecer as células do sistema imune (leucócitos) e os órgãos linfóides*
2. *Entender onde se originam os leucócitos e como são distribuídos*
3. *Definir as principais características do sistema imune inato e adaptativo*

## Capítulos de Livro

Janaway (8 ed): cap 1

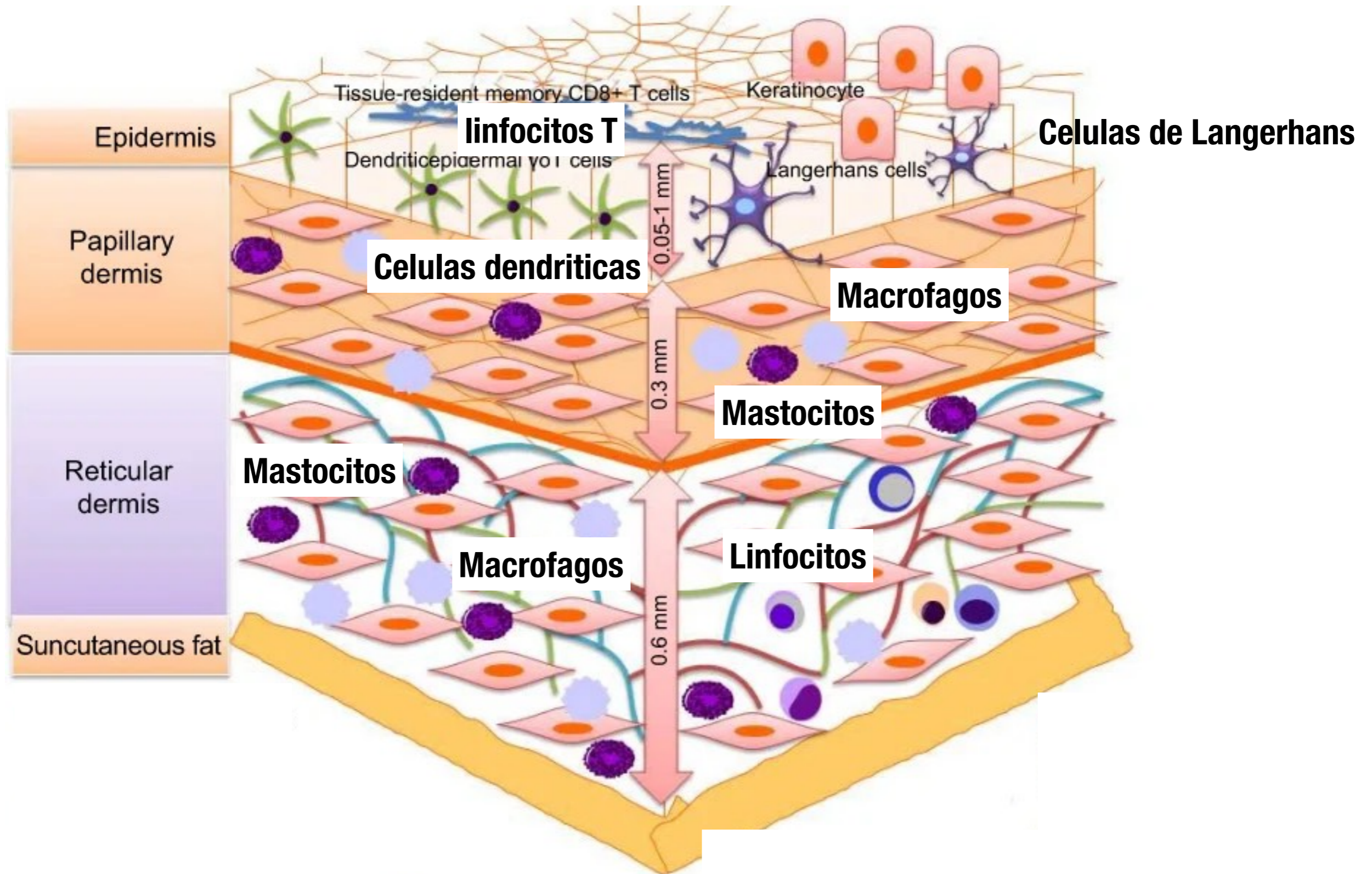
Abbas (8 ed): cap 1

Kuby (7 ed): cap 1-2



# Leucocitos teciduais

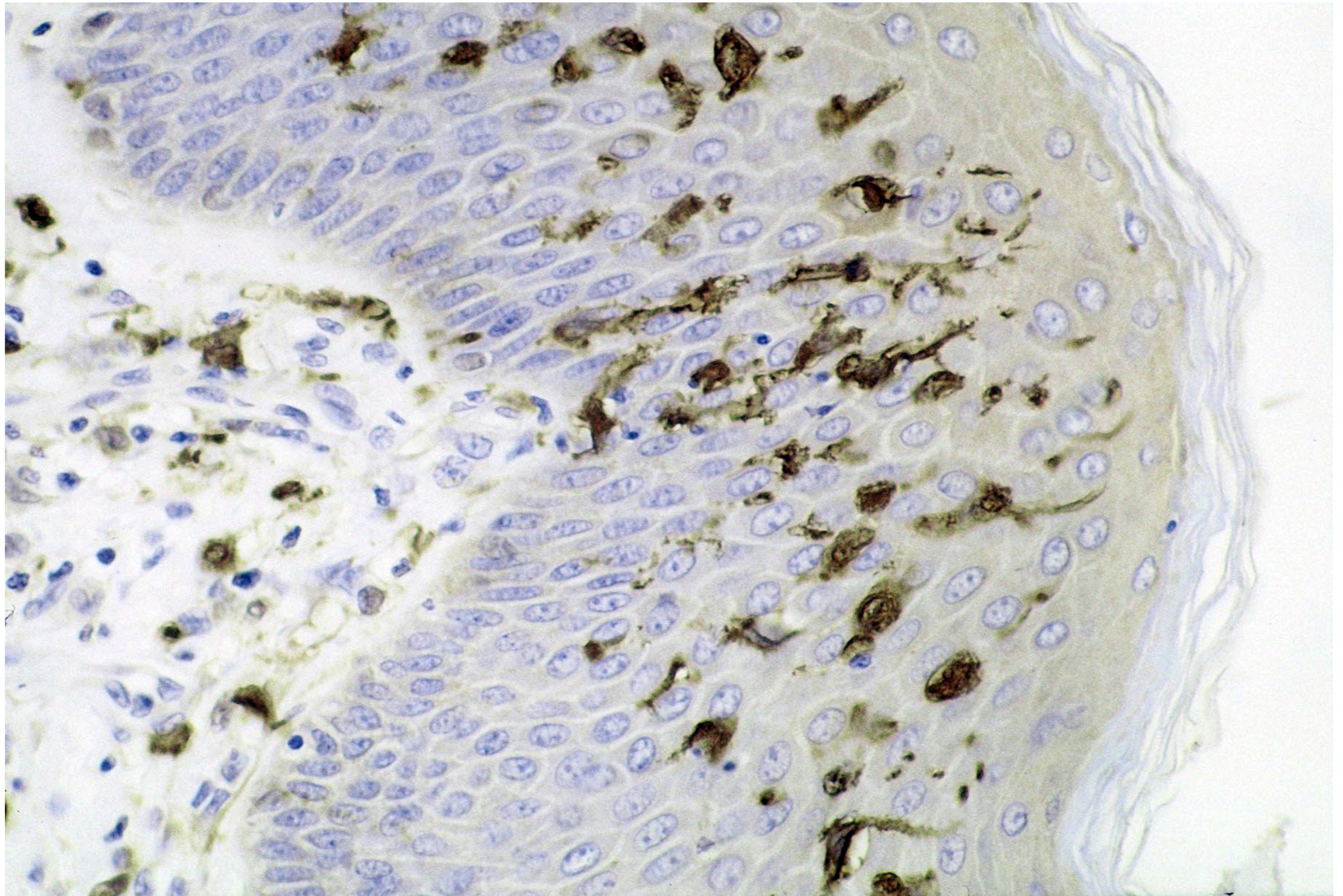
## PELE



# Leucocitos teciduais

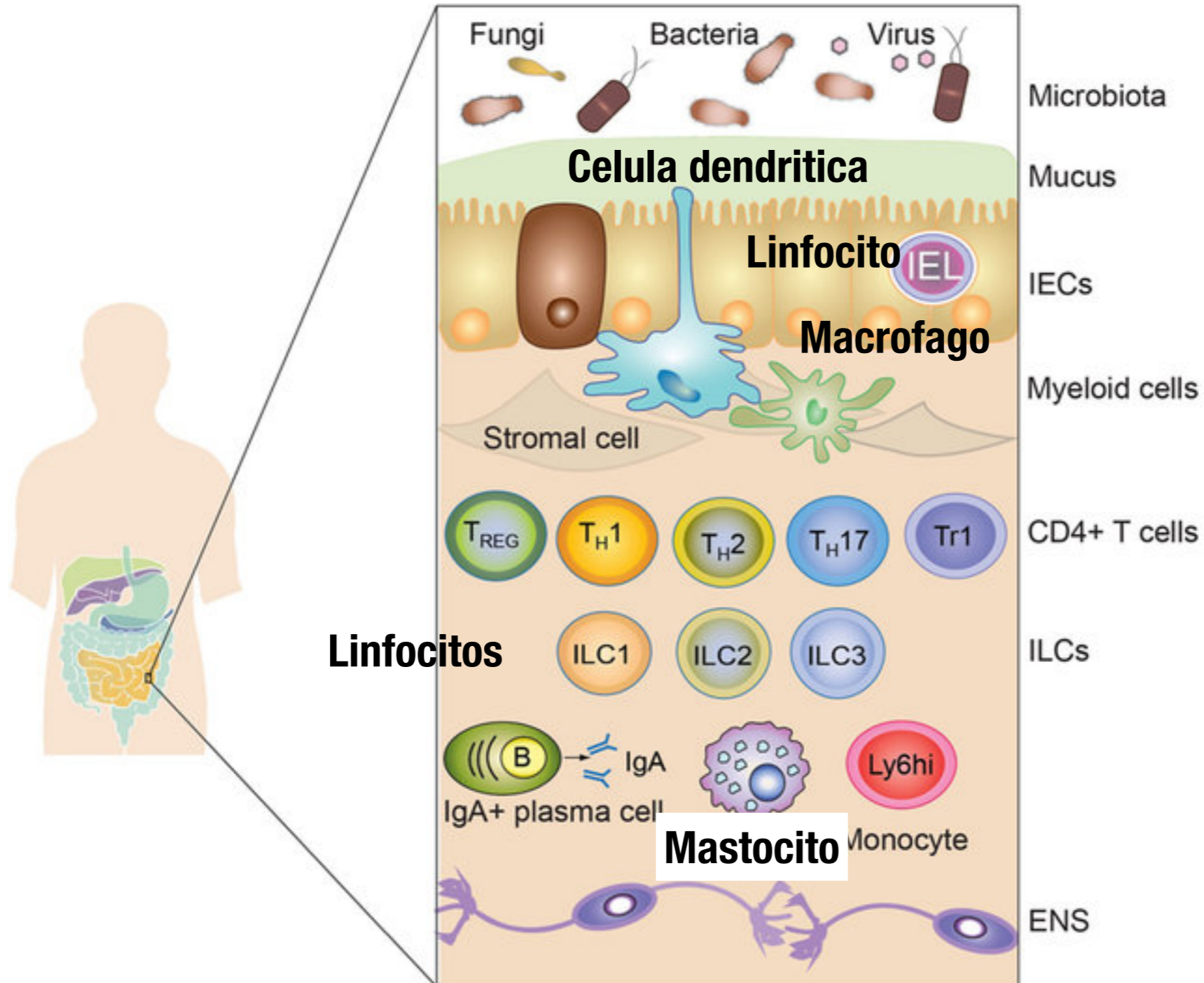
PELE

Celulas de Langerhans



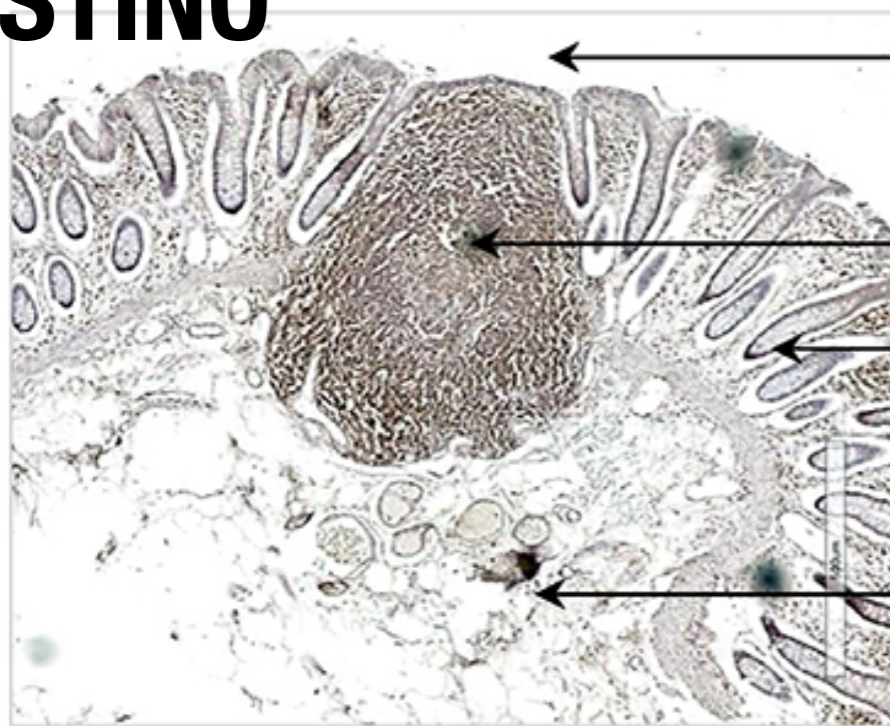
# Leucocitos teciduais

## INTESTINO



# Leucocitos teciduais

## INTESTINO



gut lumen

mucus

**Agregado linfoide**

goblet cells

epithelial crypt

fibroblasts

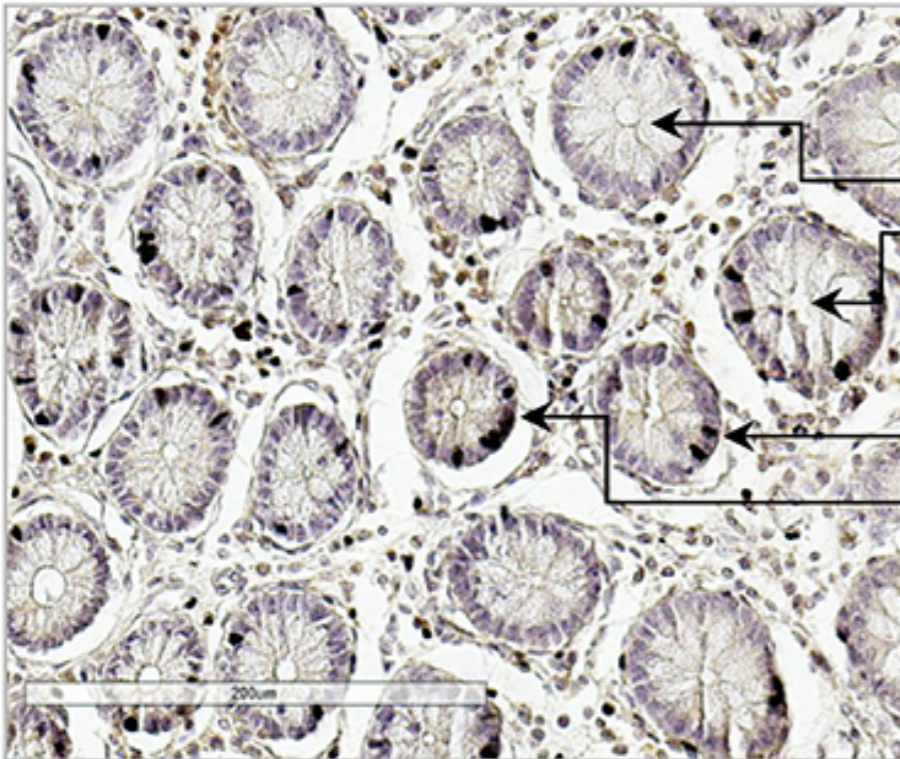
submucosa

B



## GALT

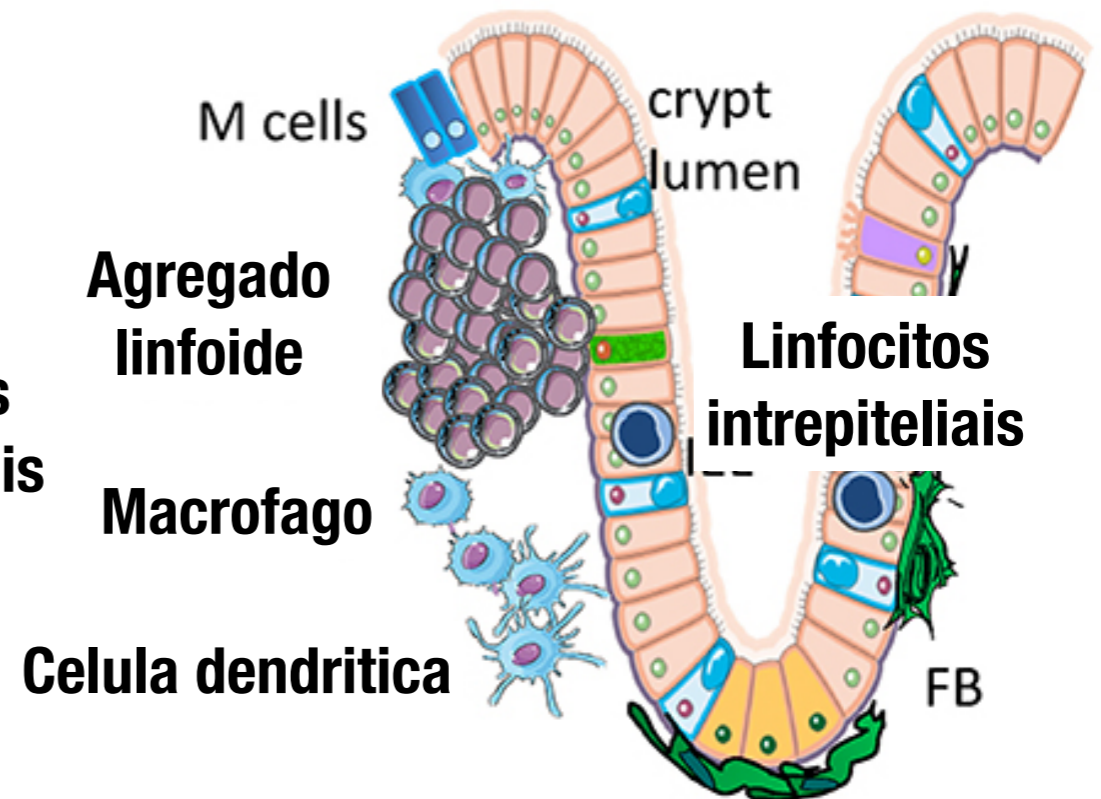
C



crypt lumen

**Linfocitos  
intrepiteliais**

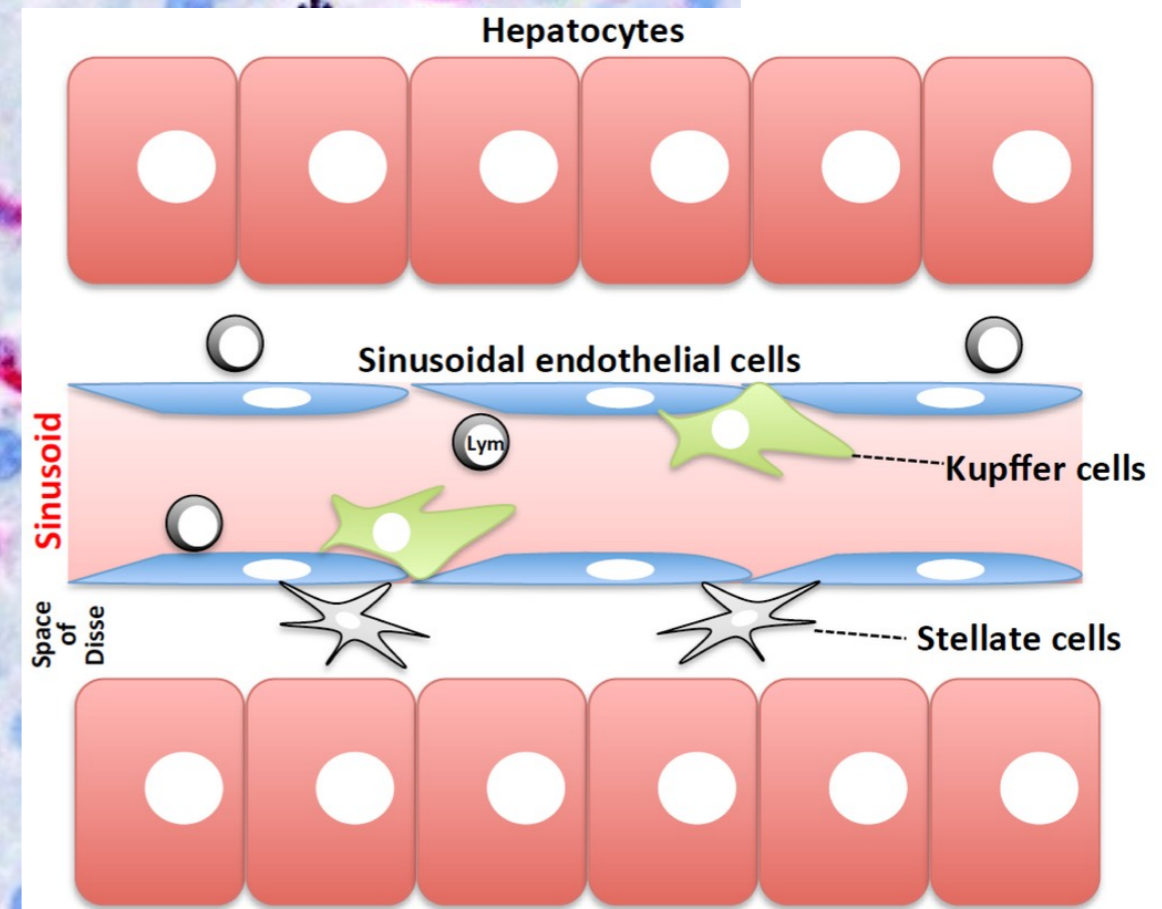
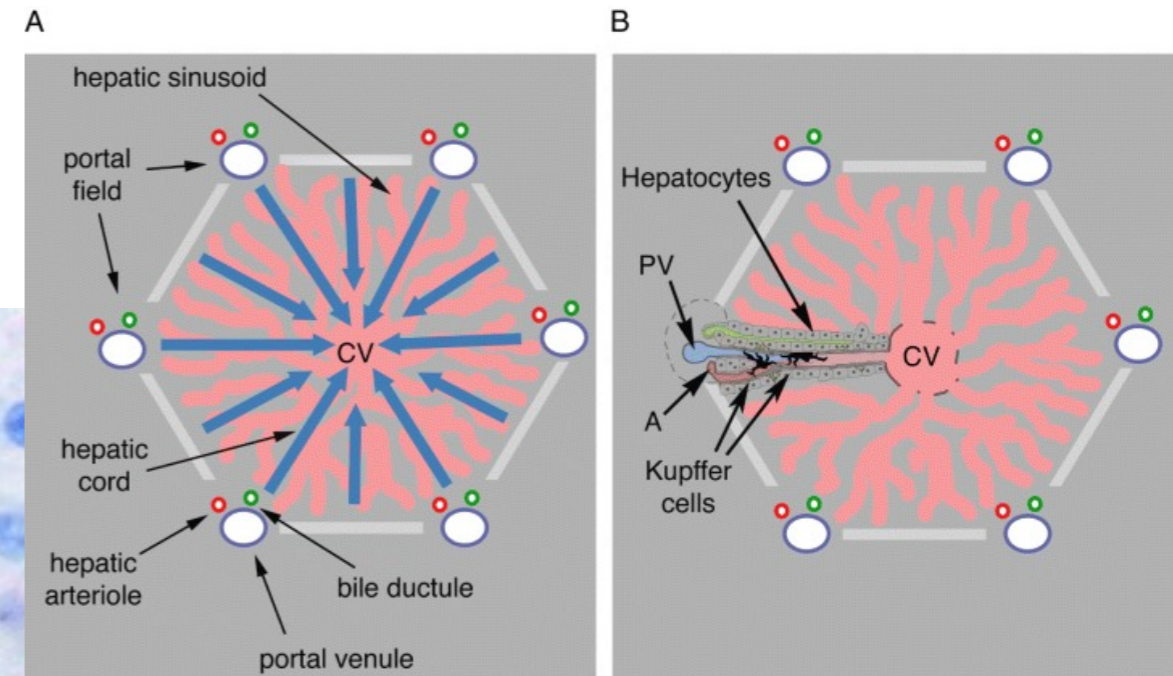
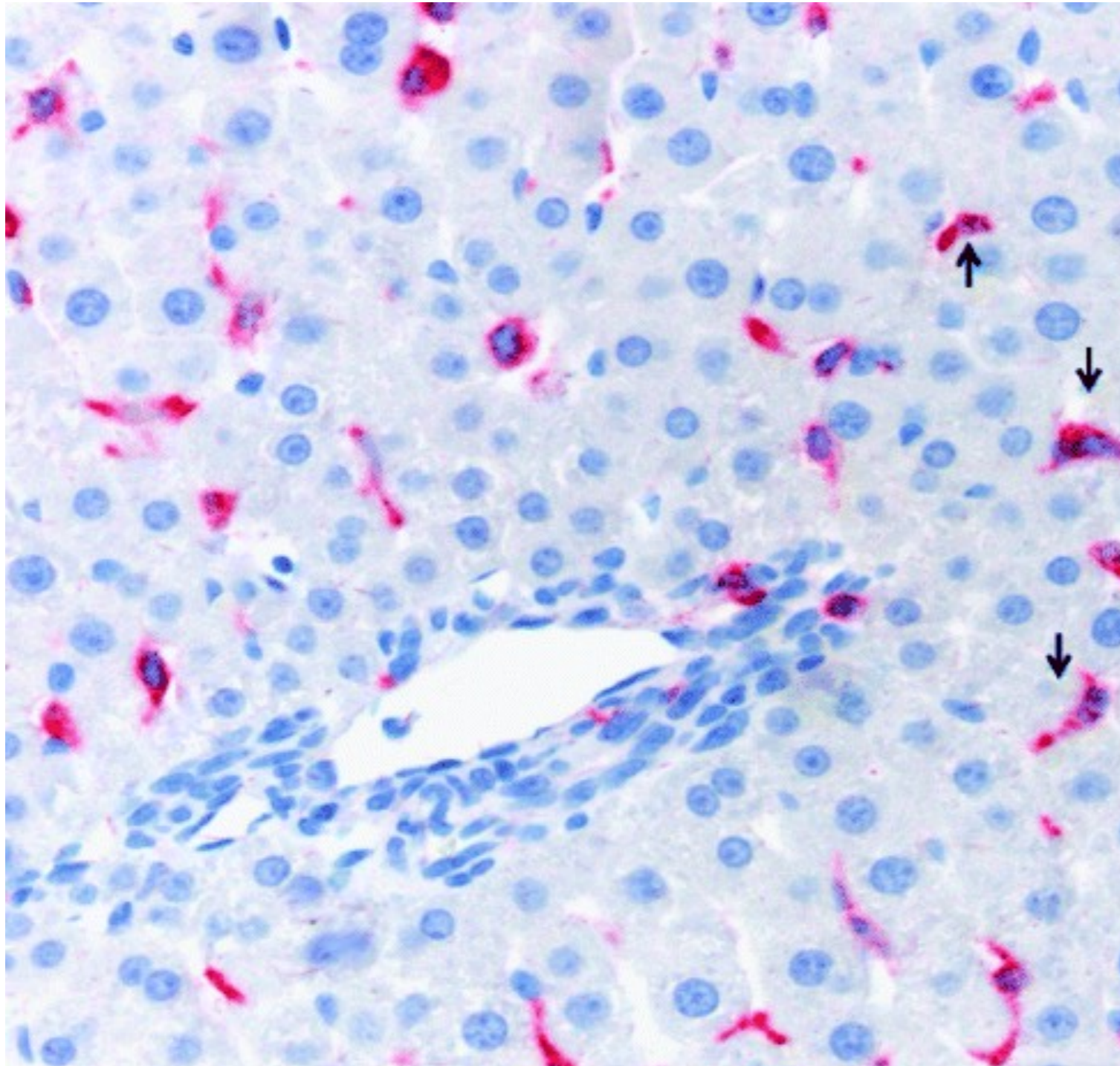
D



# Leucocitos teciduais

## FIGADO

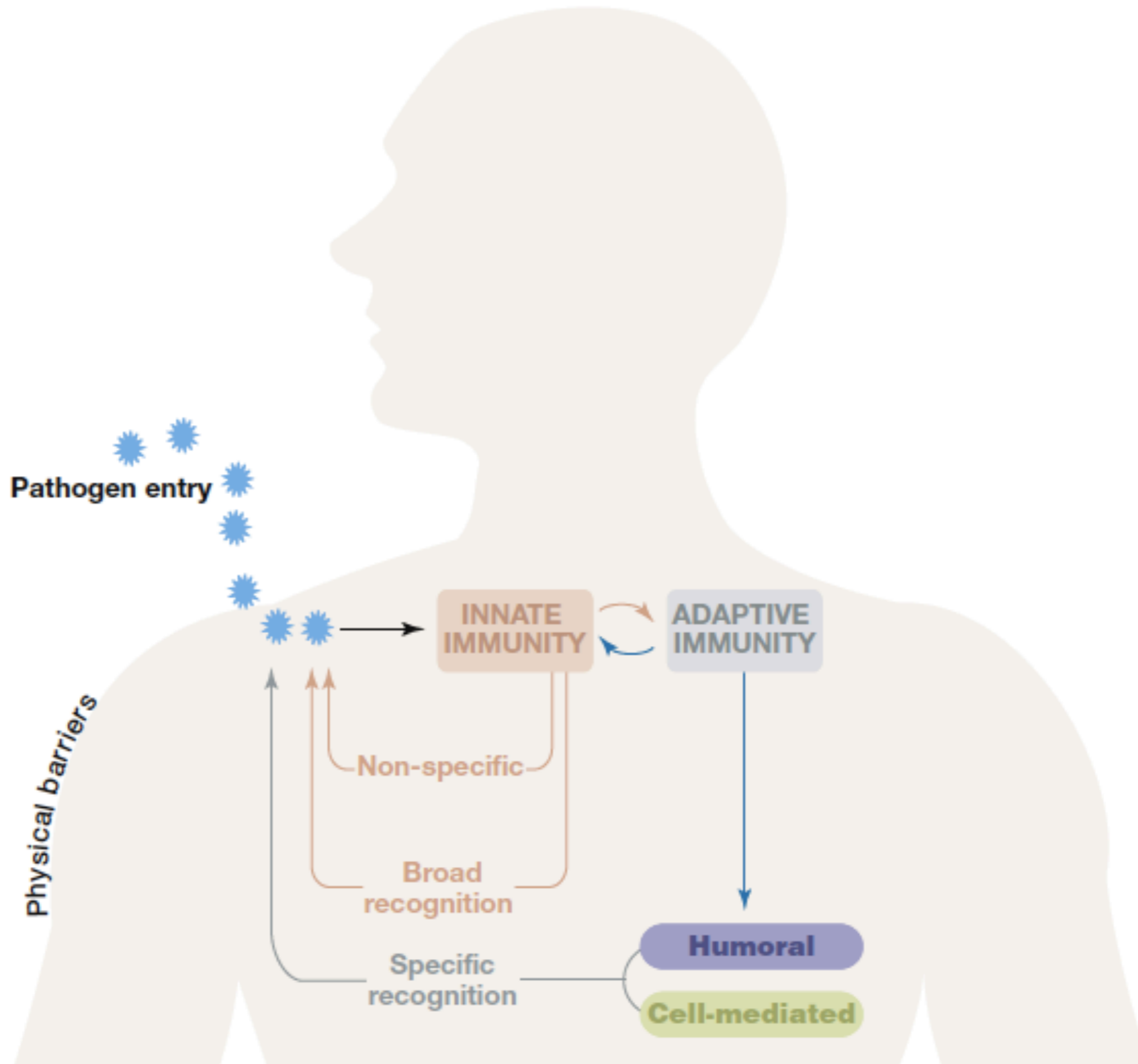
### Celulas de Kupferr







# Resposta imune



# Resposta imune

Inata



Adaptativa

1 insulto

2 insulto

Resposta inata

Resposta inata

Morte

Controle

Nao controla

Resposta adaptativa

Morte

Controle

Memoria

Livre de  
doença

Livre de  
doença

