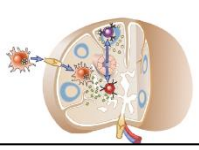


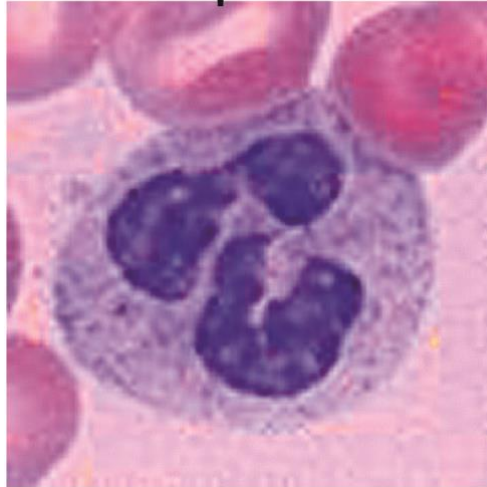
The cells of the immune system are normally present as circulating cells in the blood and lymph, as anatomical defined collections in lymphoid organs, and as scattered cells in virtually all tissues.

- Macrophages are phagocytes
- Neutrophils are phagocyte and monocytes are precursor of tissue macrophages
- Specialized tissue called peripheral lymphoid organs
- Dendritic cells are antigen presenting cells (APCs) – in almost all organs
- Naïve lymphocytes
- Effector and memory lymphocytes



Morphology of Granular Leukocytes

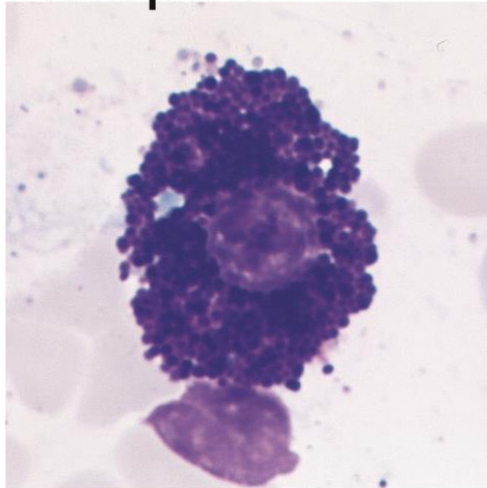
Neutrophil



Mast cell



Basophil



Eosinophil

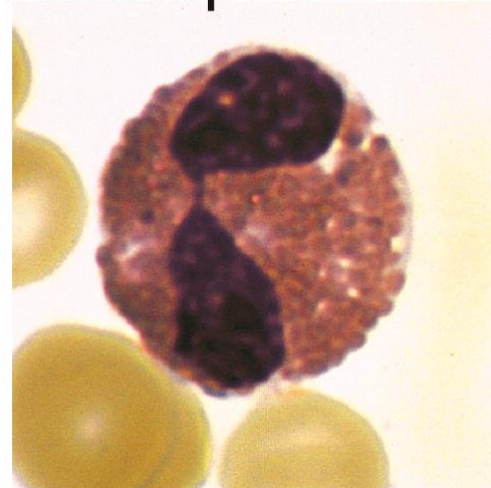
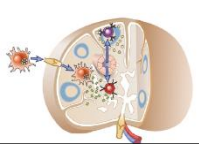
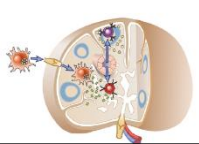


Fig. 2-1



Maturation of Macrophages and DCs

Normal blood cells count	Mean number per Microliter	Normal range
White blood cells (leucocytes)	7400	4500 - 11000
Neutrophils (polymorphonuclear leucocytes)	4400	1800 - 7700
Eosinophils	200	0 - 450
Basophils	40	0 - 200
Lymphocytes	2500	1000 - 4800
Monocytes	300	0 - 800



Maturation of Macrophages and DCs

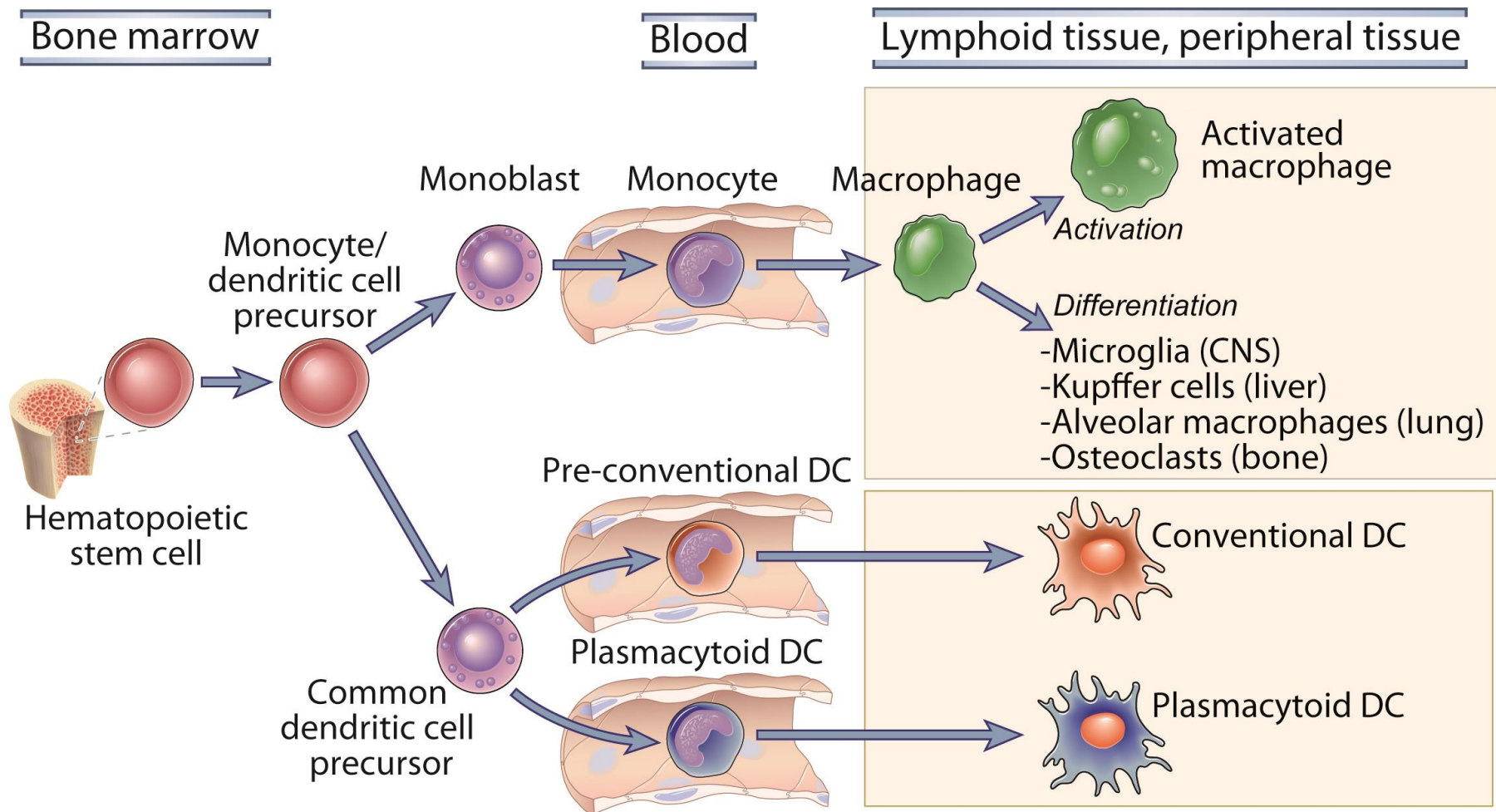
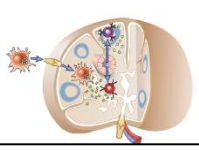
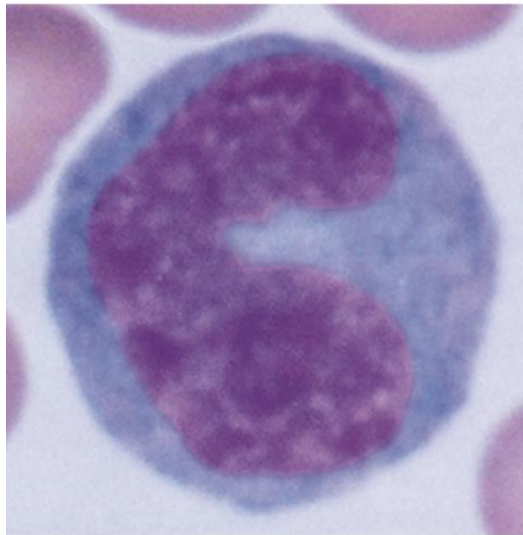


Fig. 2-2



Monocytes and Macrophages

Blood Monocytes



Activated tissue macrophage

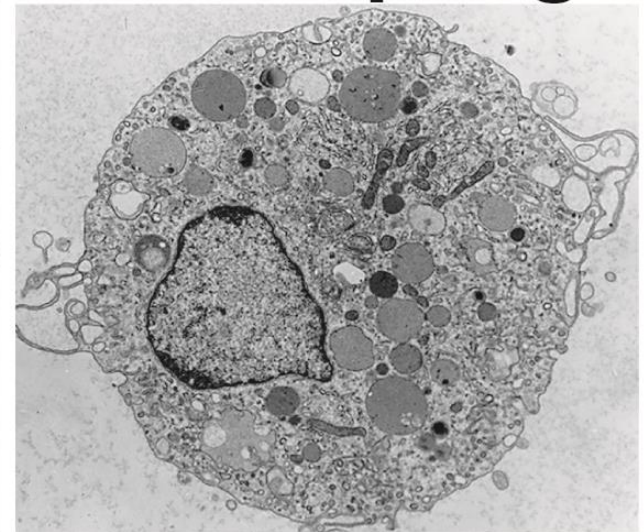
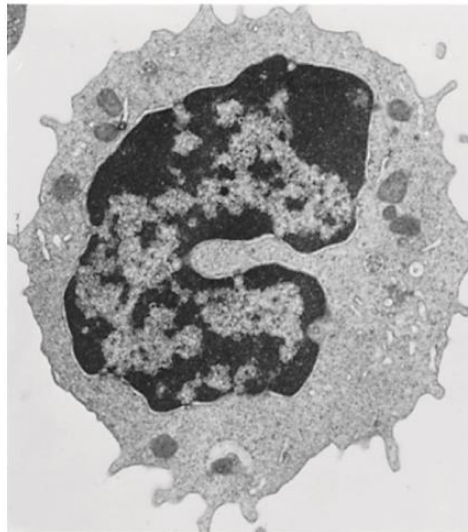
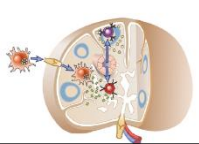


Fig. 2-3



Dendritic cell

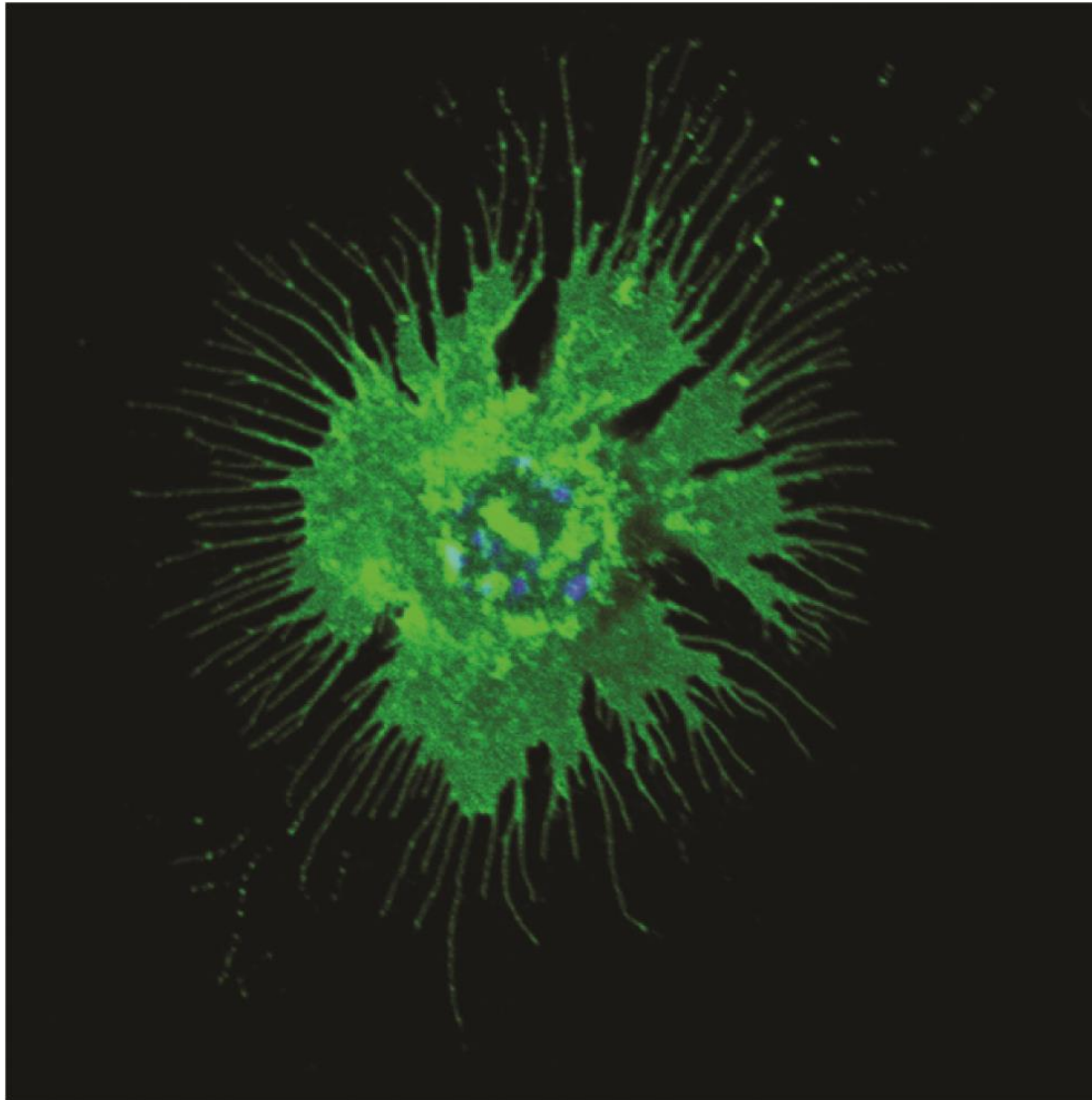
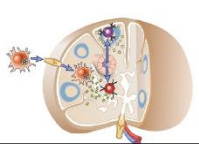


Fig. 2-4



Maturation of Lymphocytes

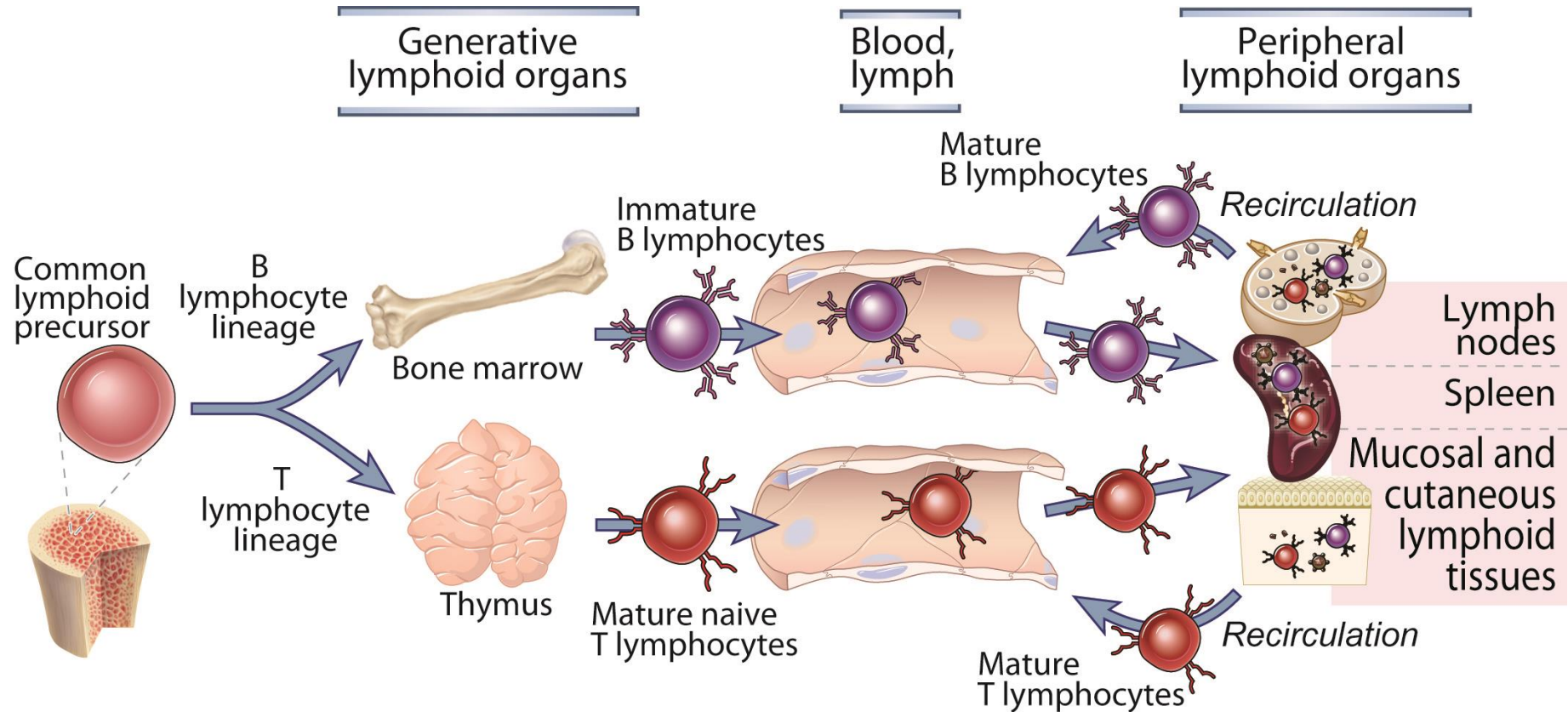


Fig. 2-5

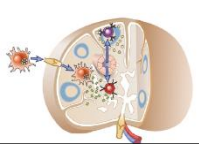
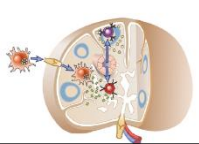


TABLE 2-2 Lymphocyte Classes Morphological- they look the same

Class	Functions	Antigen Receptor and Specificity	Selected Phenotype Markers	Percentage of Total Lymphocytes (Human)		
				Blood	Lymph Node	Spleen
$\alpha\beta$ T lymphocytes						
CD4 ⁺ helper T lymphocytes	B cell differentiation (humoral immunity) Macrophage activation (cell-mediated immunity) Stimulation of inflammation	$\alpha\beta$ heterodimers Diverse specificities for peptide–class II MHC complexes	CD3 ⁺ , CD4 ⁺ , CD8 [−]	50-60*	50-60	50-60
CD8 ⁺ cytotoxic T lymphocytes	Killing of cells infected with viruses or intracellular bacteria; rejection of allografts	$\alpha\beta$ heterodimers Diverse specificities for peptide–class I MHC complexes	CD3 ⁺ , CD4 [−] , CD8 ⁺	20-25	15-20	10-15
Regulatory T cells	Suppress function of other T cells (regulation of immune responses, maintenance of self-tolerance)	$\alpha\beta$ heterodimers Unresolved	CD3 ⁺ , CD4 ⁺ , CD25 ⁺ (most common, but other phenotypes as well)	Rare	10	10
$\gamma\delta$ T lymphocytes	Helper and cytotoxic functions (innate immunity)	$\gamma\delta$ heterodimers Limited specificities for peptide and nonpeptide antigens	CD3 ⁺ , CD4 [−] , and CD8 variable			
B lymphocytes	Antibody production (humoral immunity)	Surface antibody Diverse specificities for all types of molecules	Fc receptors; class II MHC; CD19, CD21	10-15	20-25	40-45
Natural killer cells	Cytotoxic killing of virus-infected or damaged cells (innate immunity)	Various activating and inhibitory receptors Limited specificities for MHC or MHC-like molecules	CD16 (Fc receptor for IgG)	10	Rare	10
NKT cells	Suppress or activate innate and adaptive immune responses	$\alpha\beta$ heterodimers Limited specificity for glycolipid-CD1 complexes	CD16 (Fc receptor for IgG); CD3	10	Rare	10

*In most cases, the ratio of CD4⁺CD8[−] to CD8⁺CD4[−] is about 2:1.
IgG, immunoglobulin G; MHC, major histocompatibility complex.

Called lymphocytes based on morphology



Anatomy of Lymphocyte Activation (1)

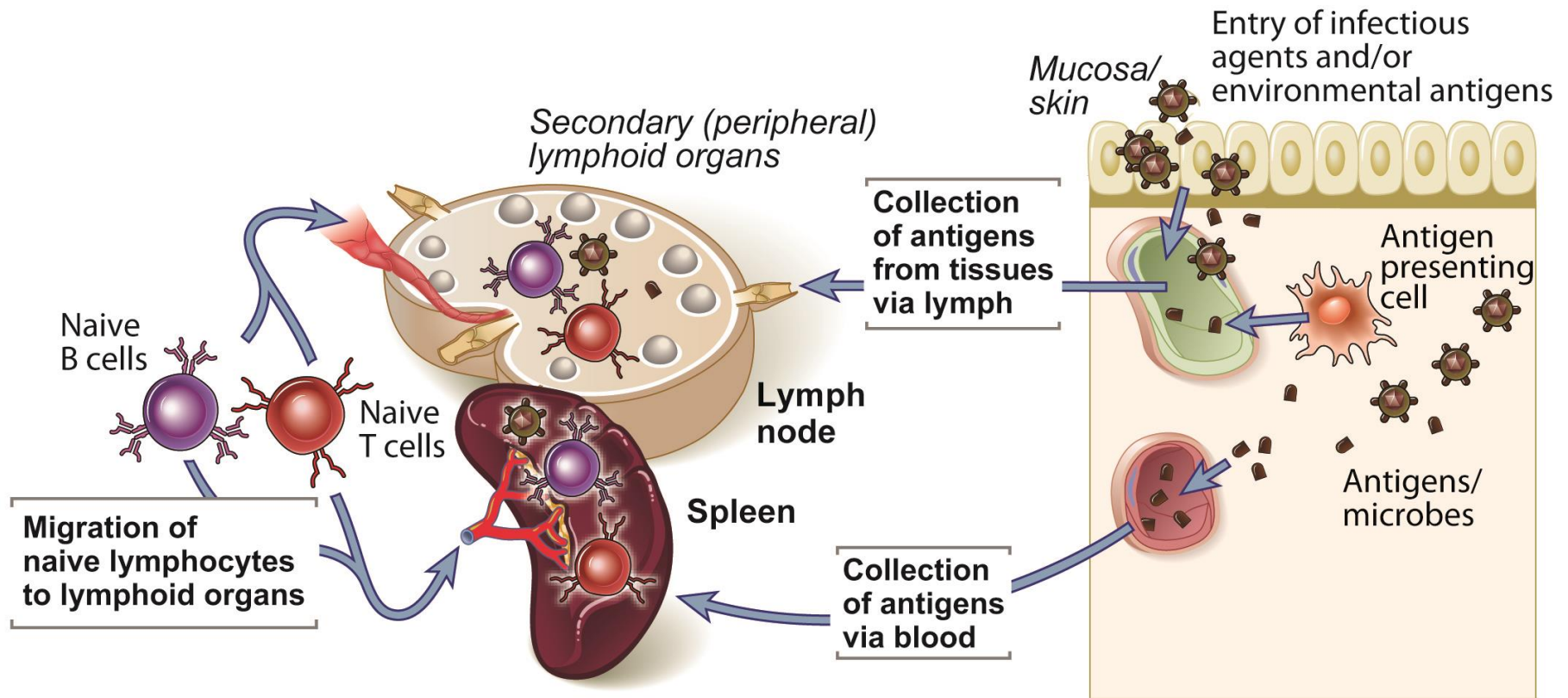
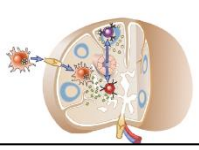


Fig. 2-6



Anatomy of Lymphocyte Activation (2)

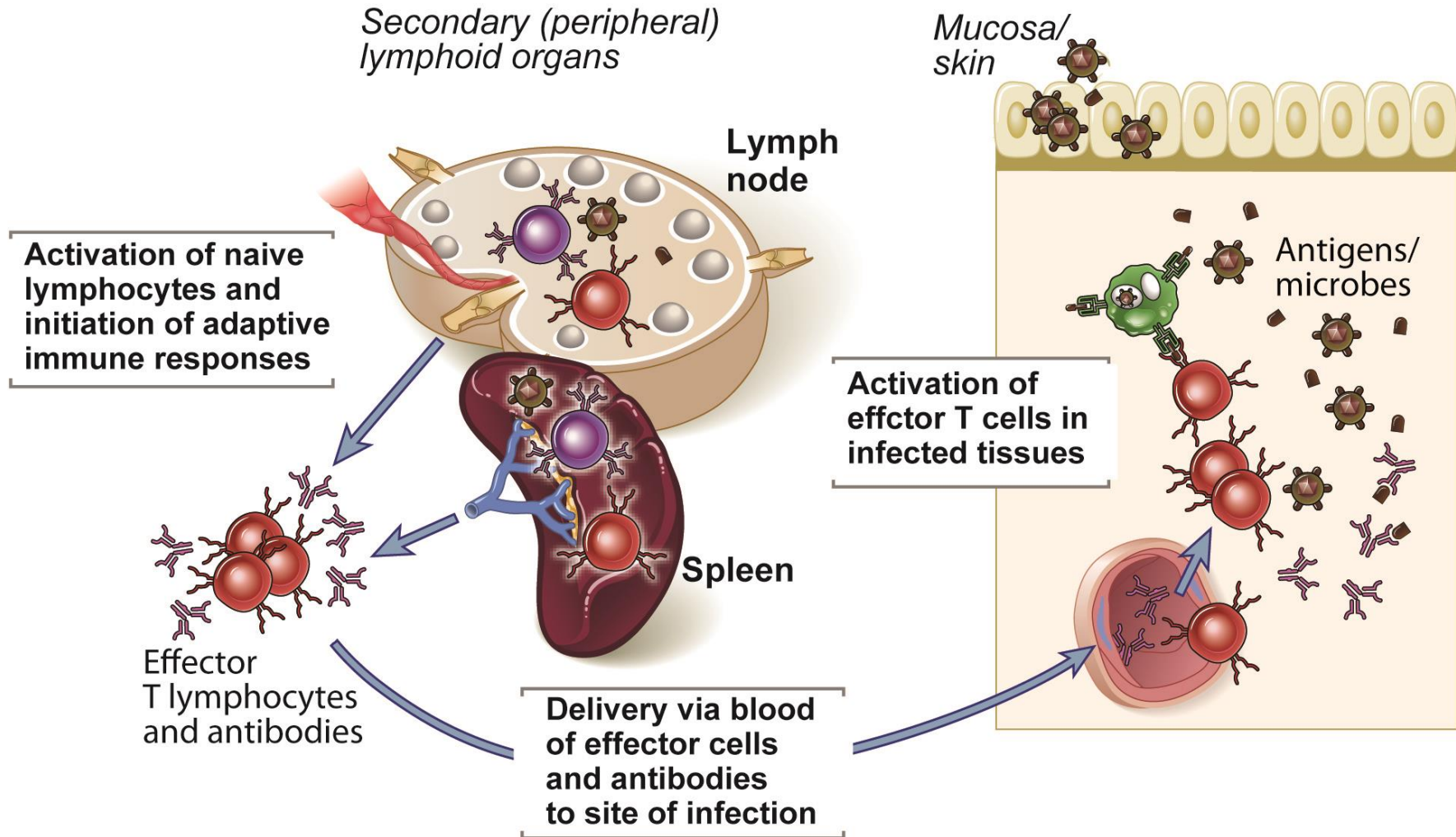
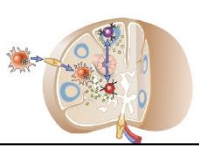
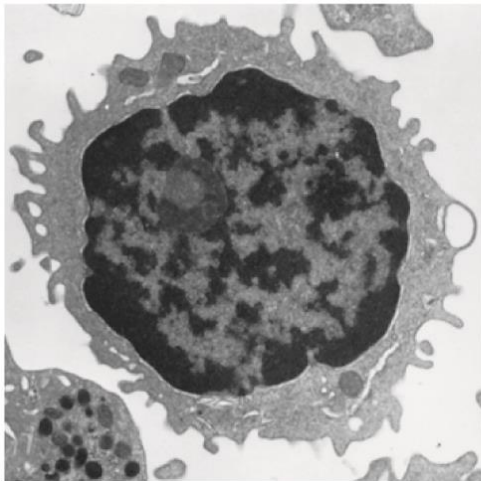
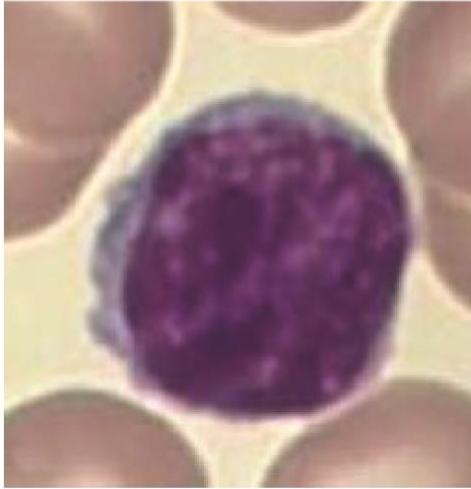


Fig. 2-6



Morphology of Lymphocytes

Small lymphocyte



Lymphoblast

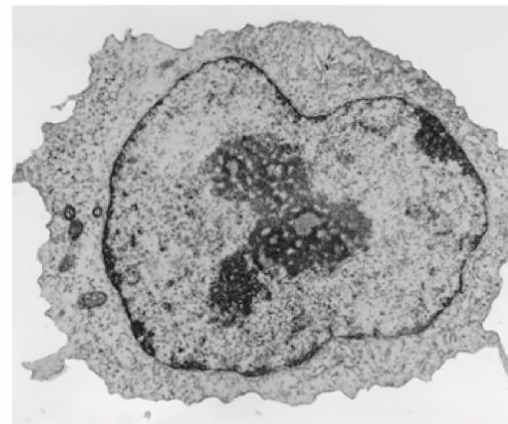
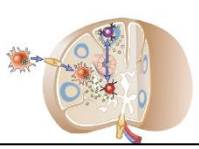


Fig. 2-7



Morphology of Plasma Cells

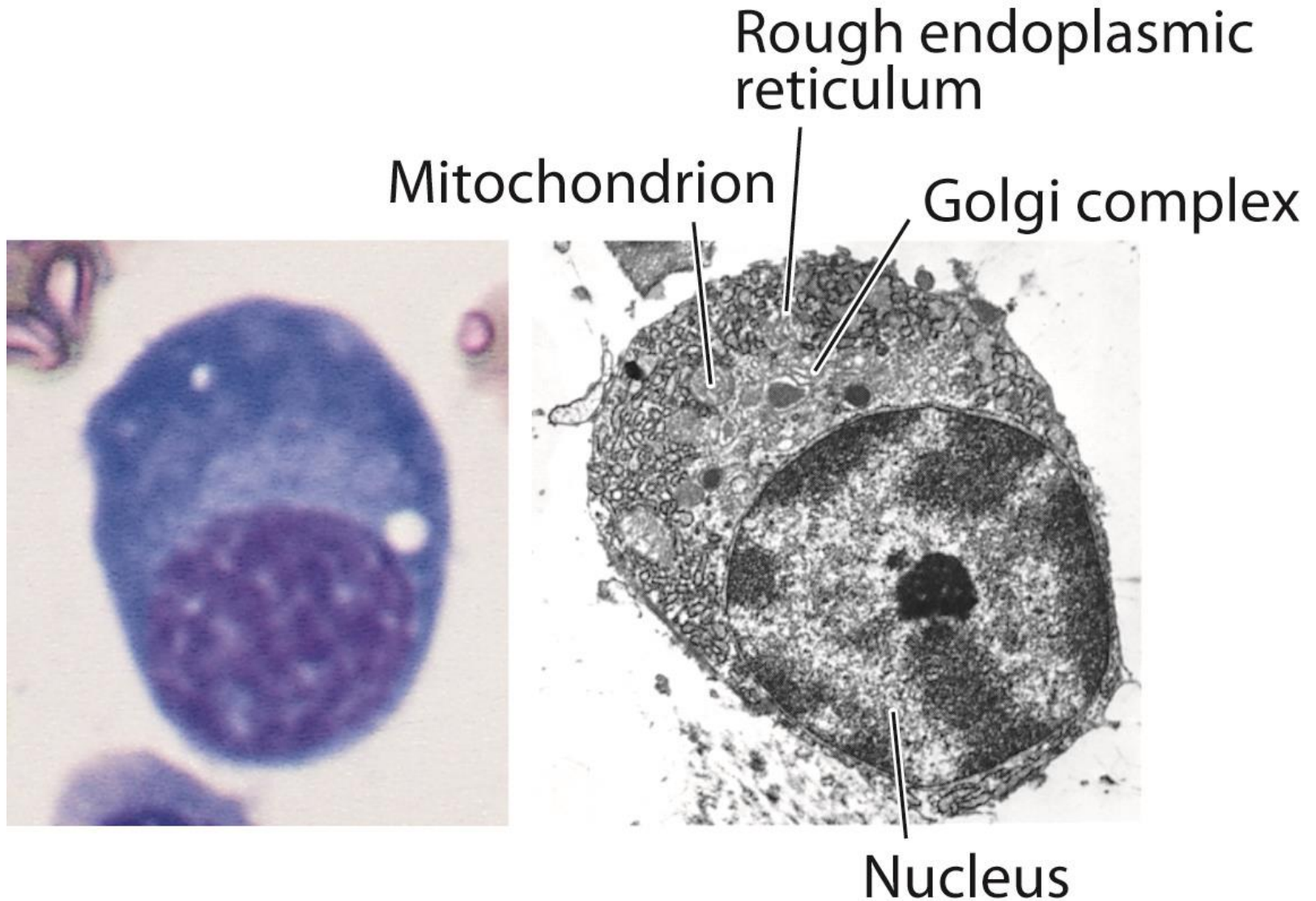
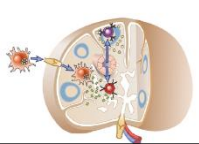
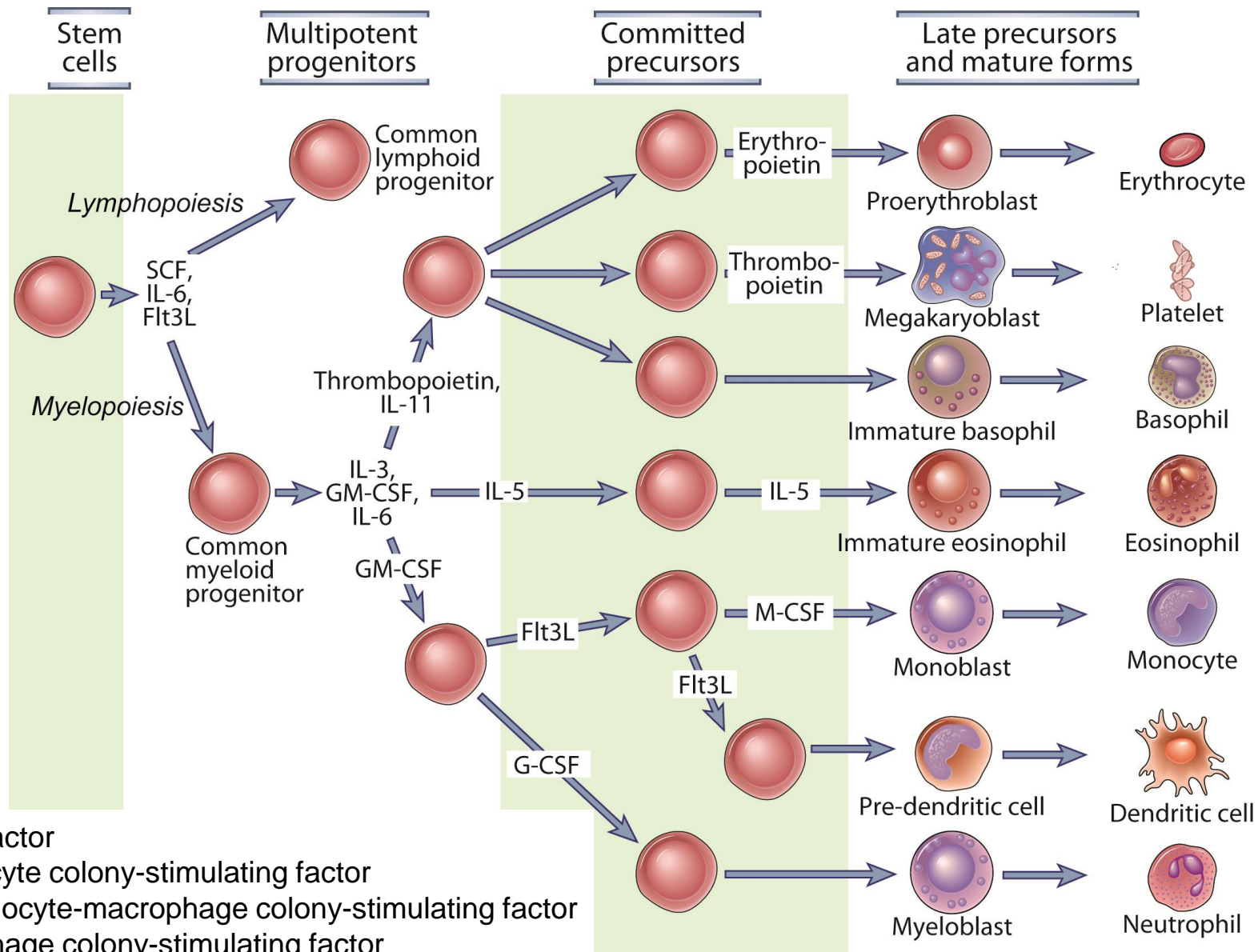
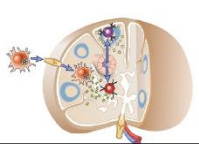


Fig. 2-8



Hematopoiesis





Hematopoiesis

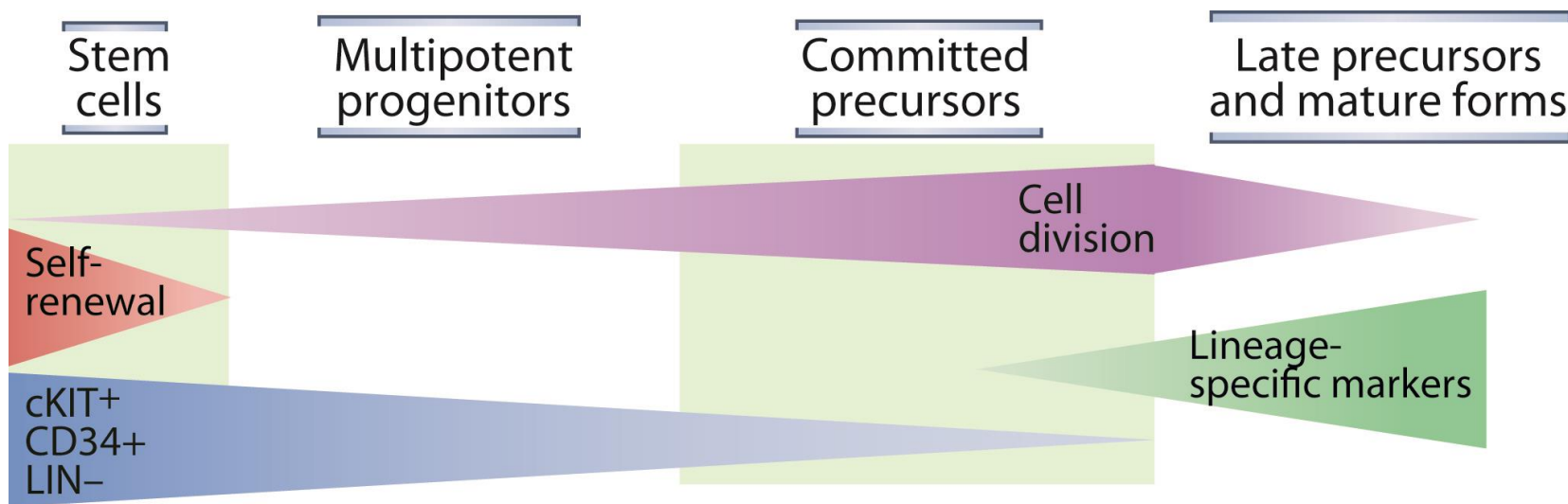
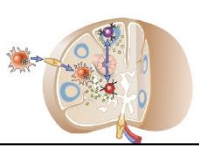


Fig. 2-9 B



Morphology of the Thymus

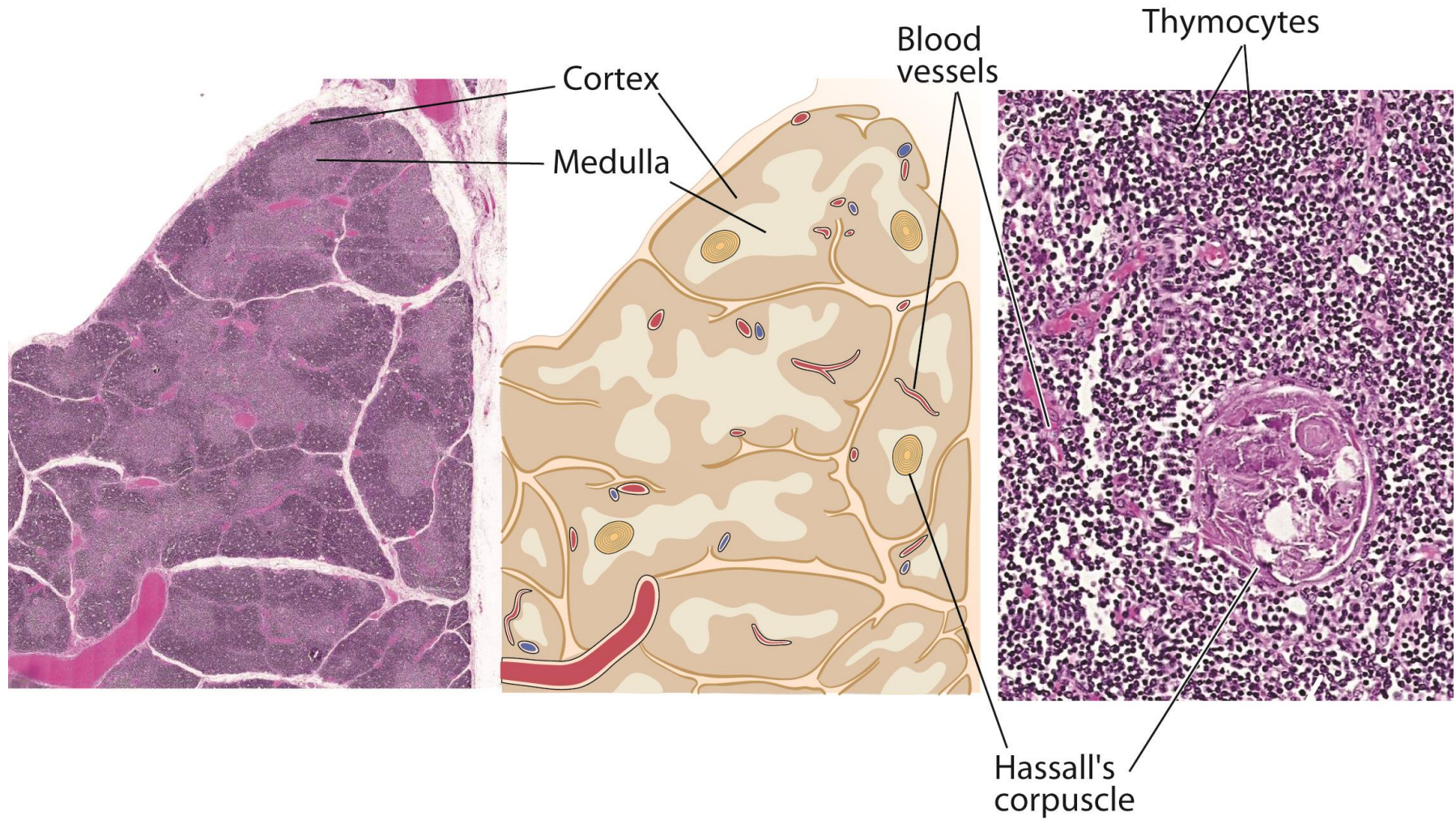
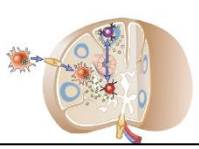


Fig. 2-10



The Lymphatic System

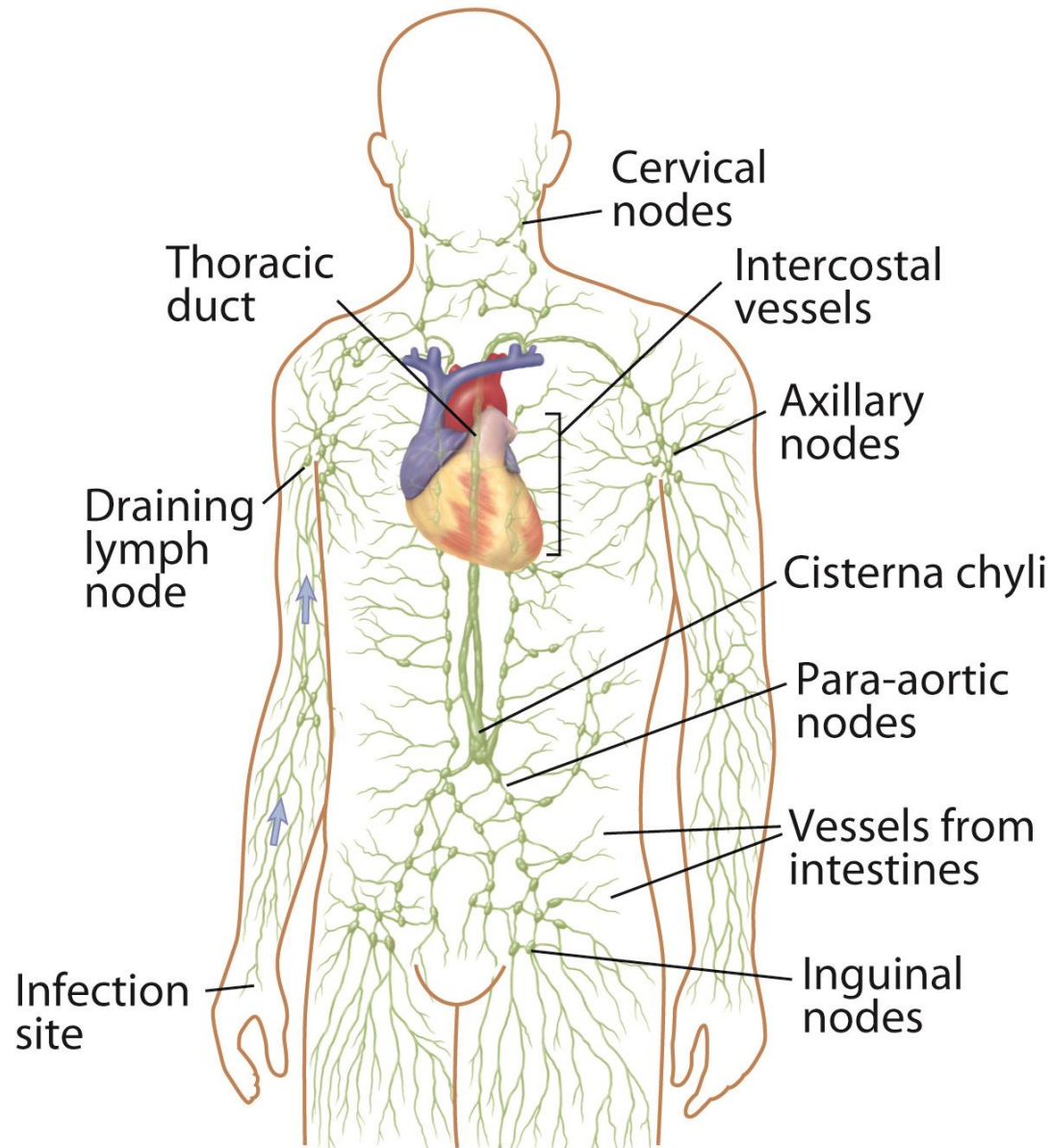
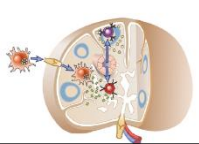


Fig. 2-11



Lymph Node Morphology (1)

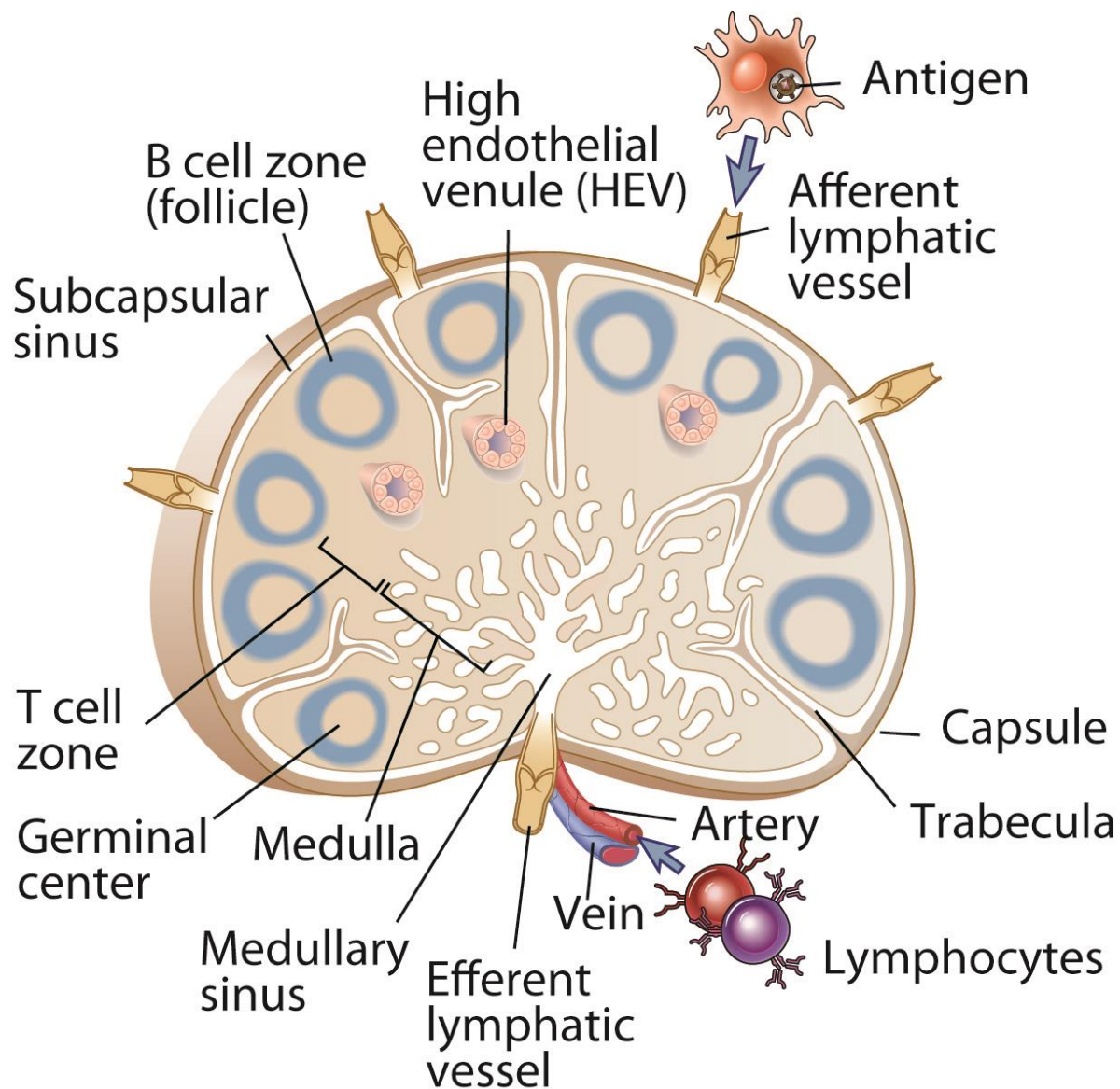
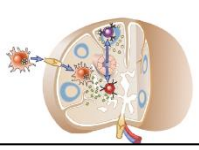


Fig. 2-12 A



Lymph Node Morphology (2)

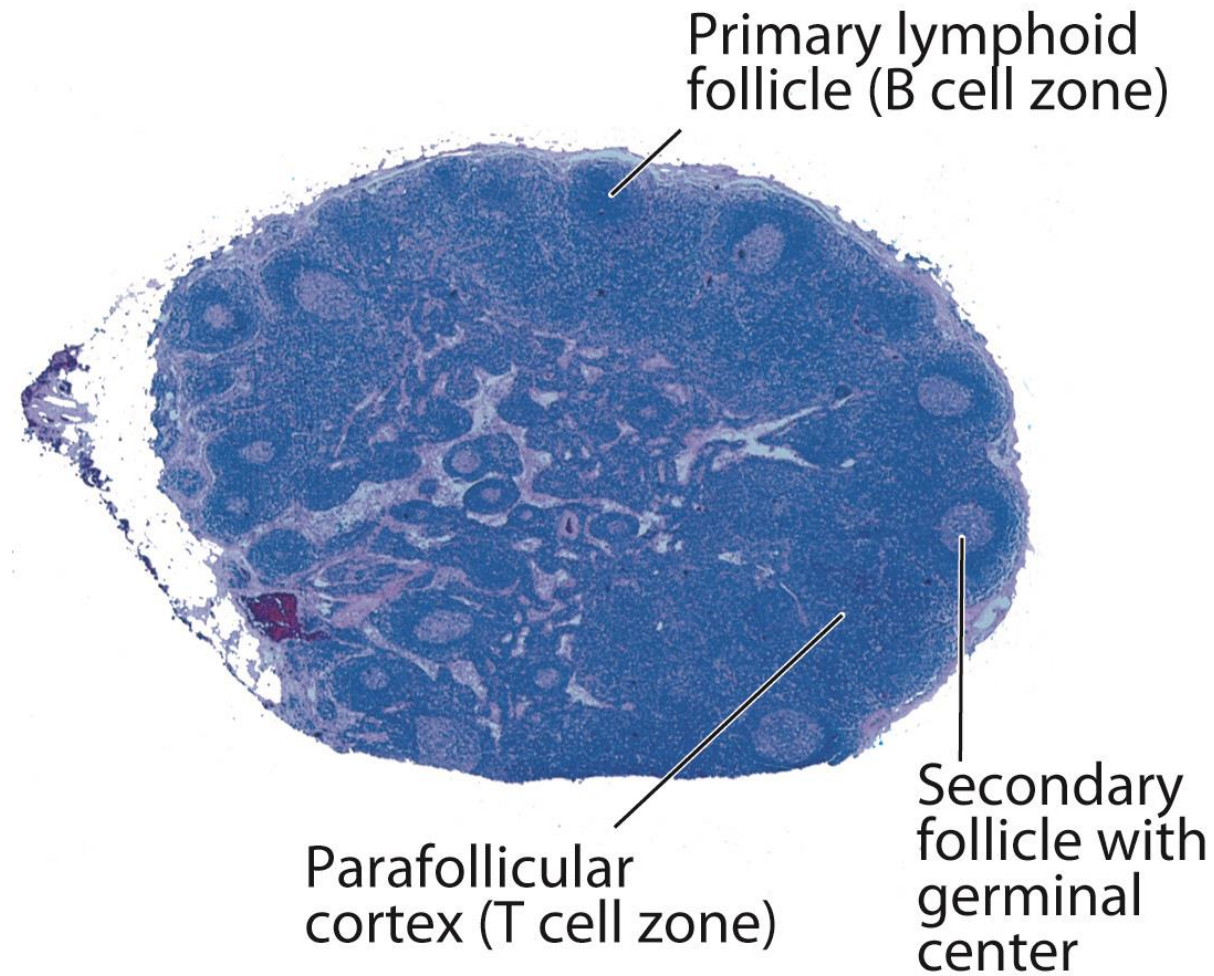
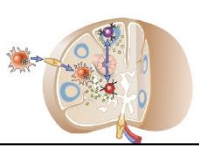


Fig. 2-12 B



B and T Cells Zones in a Lymph Node (1)

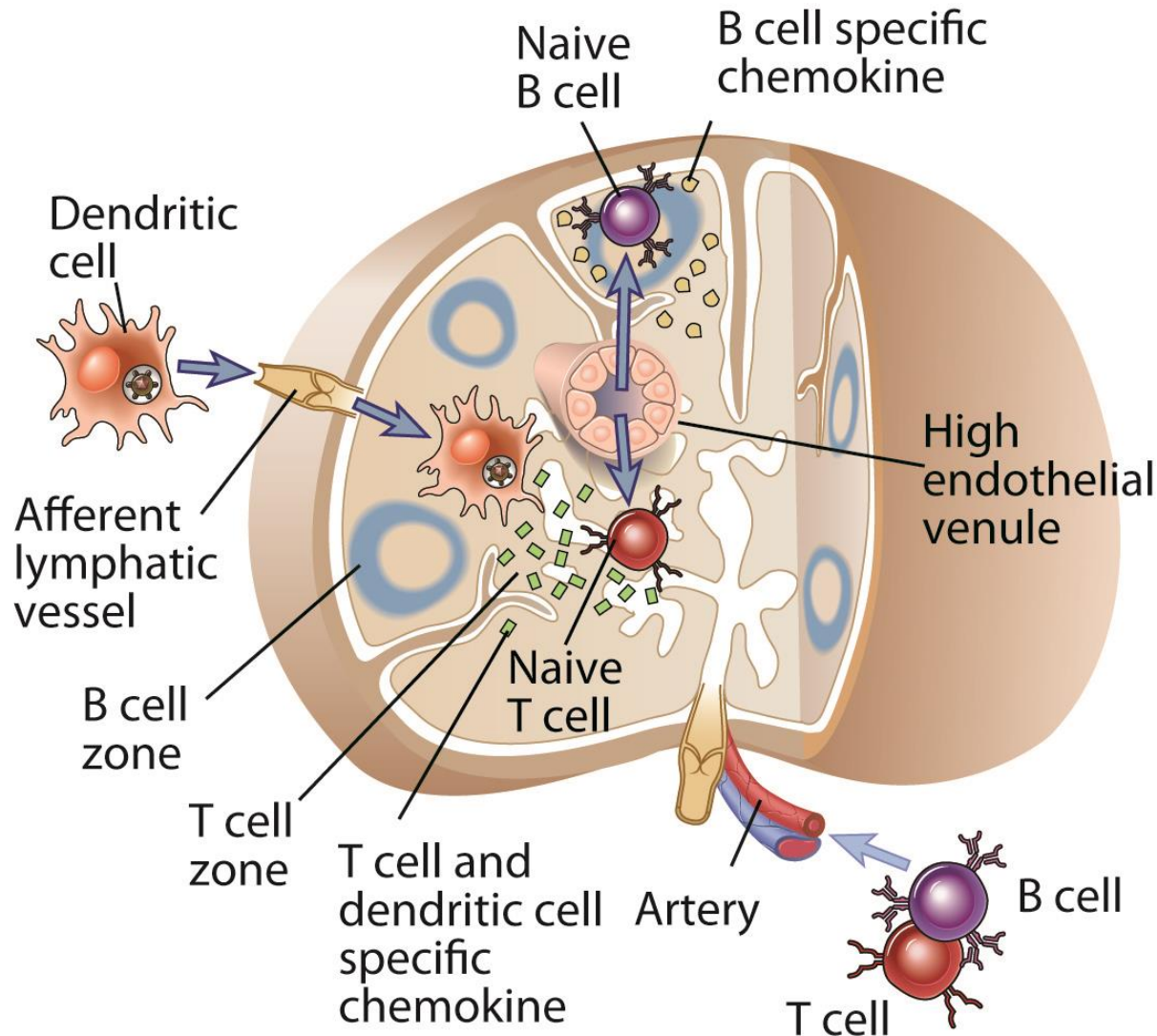
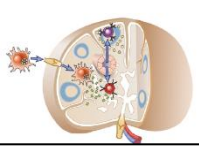


Fig. 2-13 A



B and T Cells Zones in a Lymph Node (2)

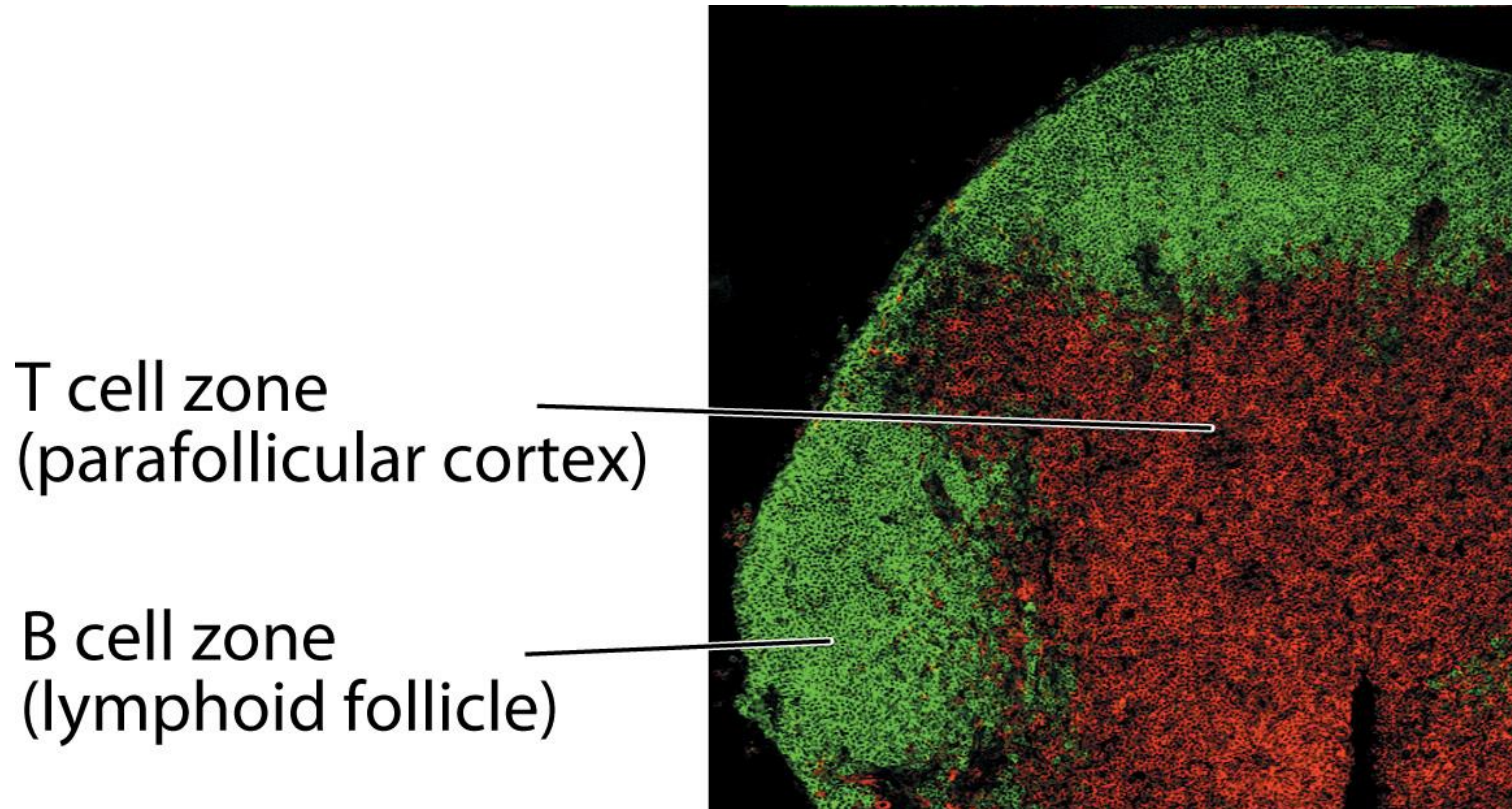
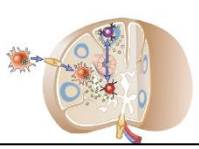
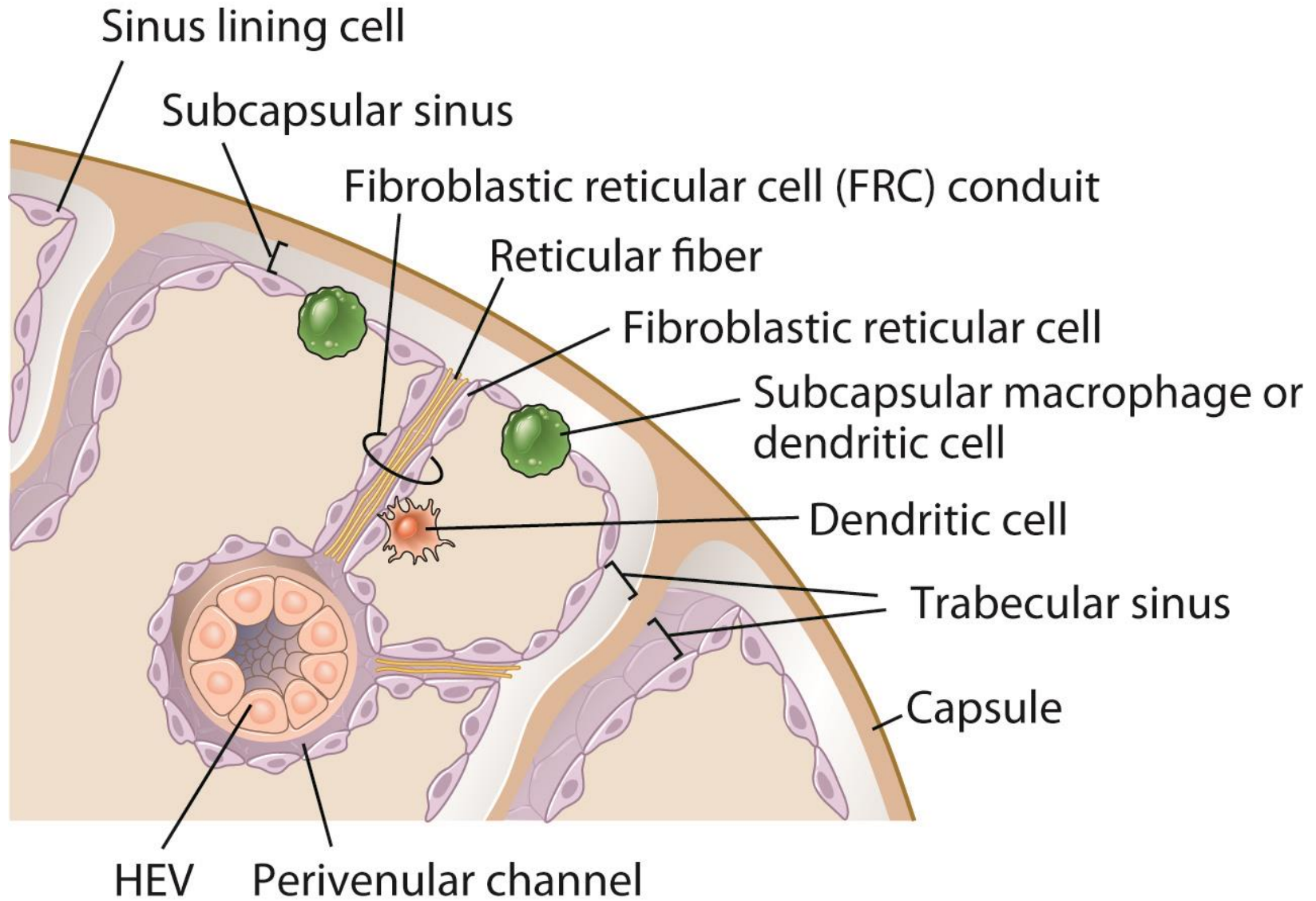


Fig. 2-13 B

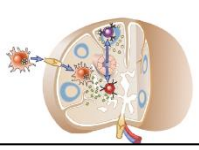


Microanatomy of Lymph Node Cortex (1)



HEV = High Endothelial Venules

Fig. 2-14 A



Microanatomy of Lymph Node Cortex (2)

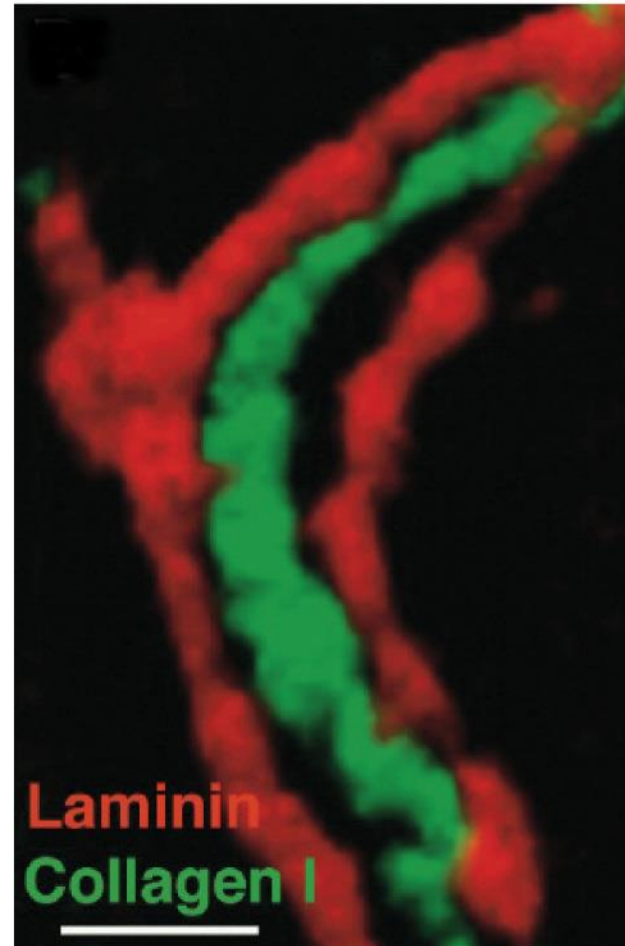
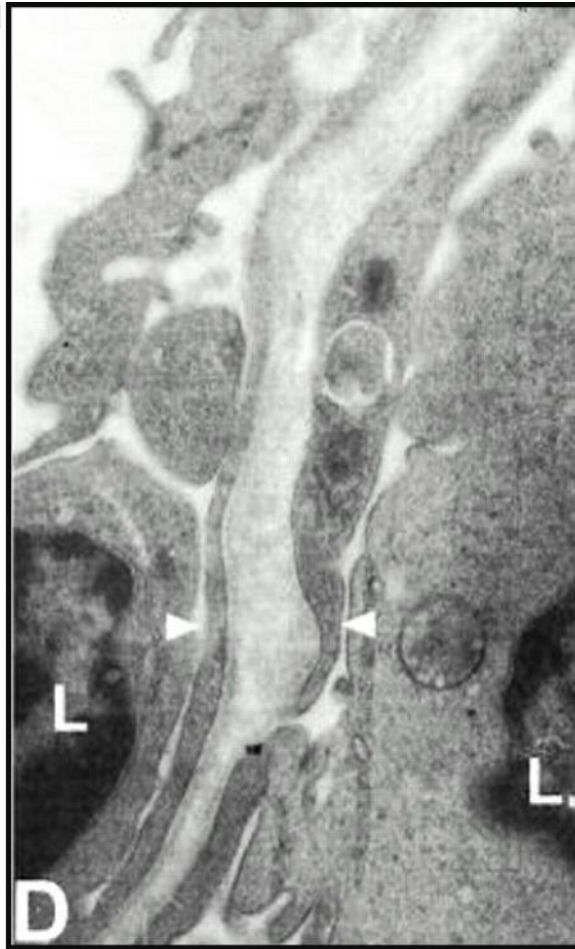
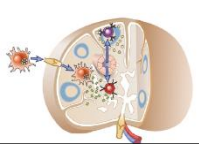


Fig. 2-14 B,C



Morphology of the Spleen (1)

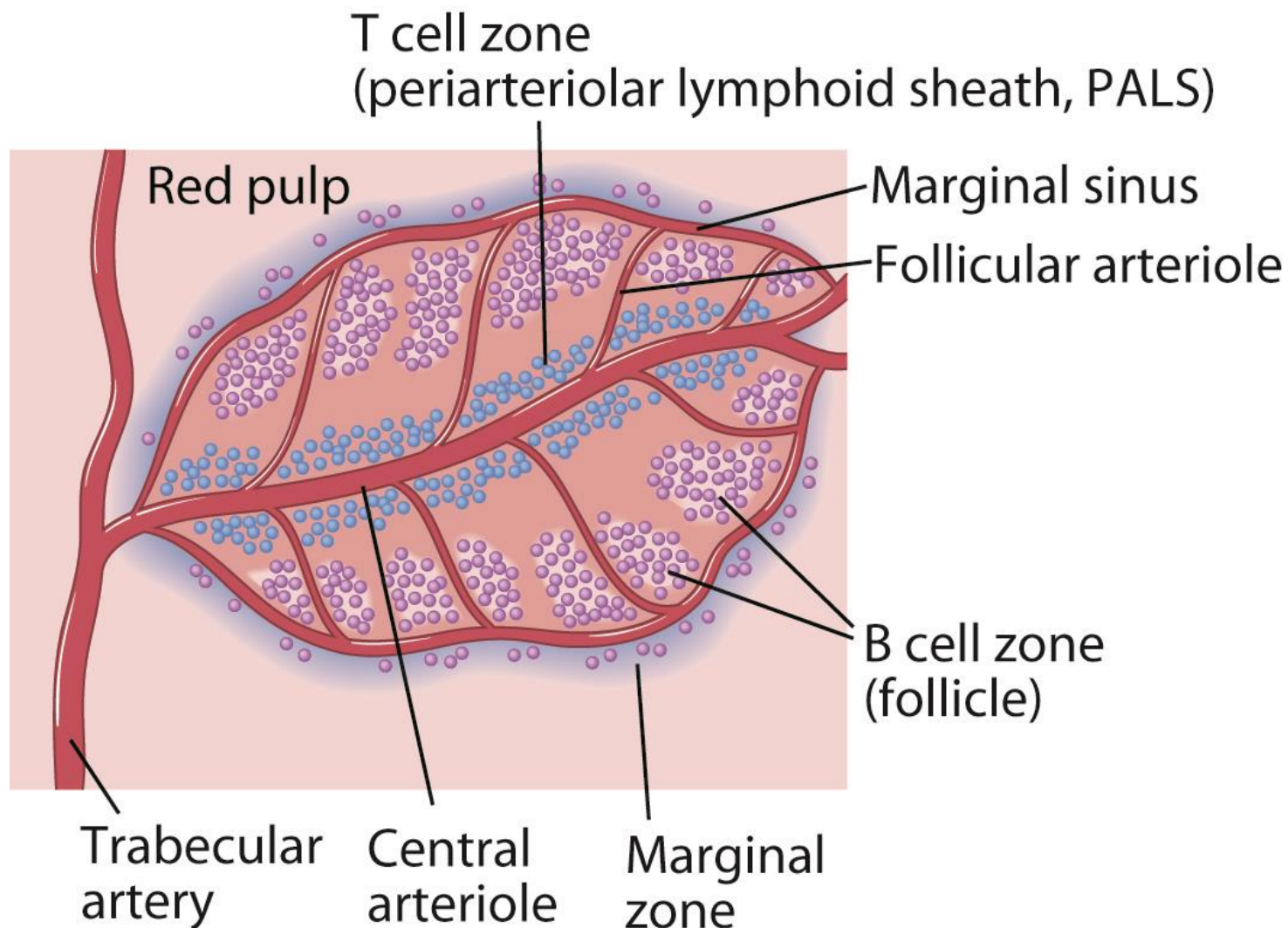
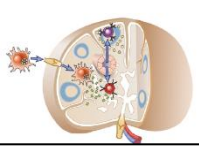
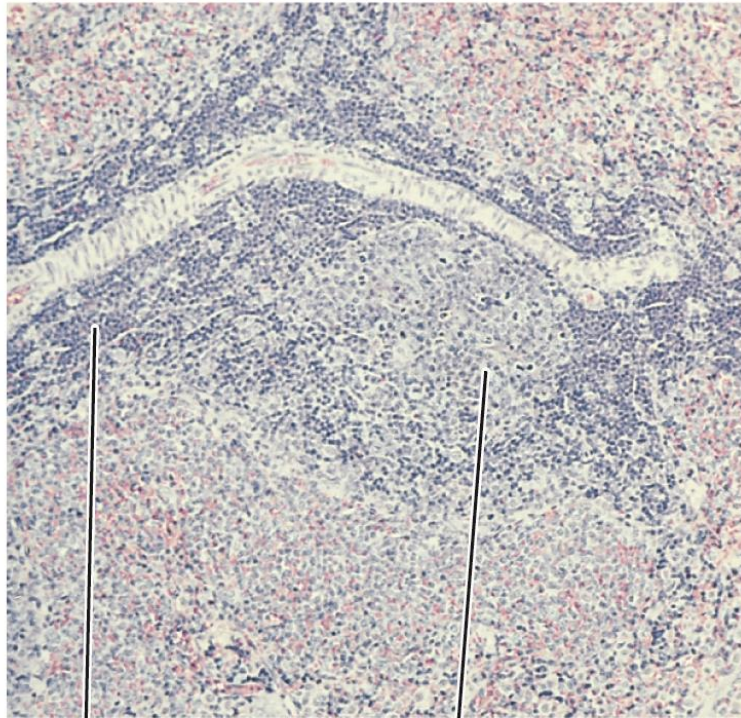


Fig. 2-16 A

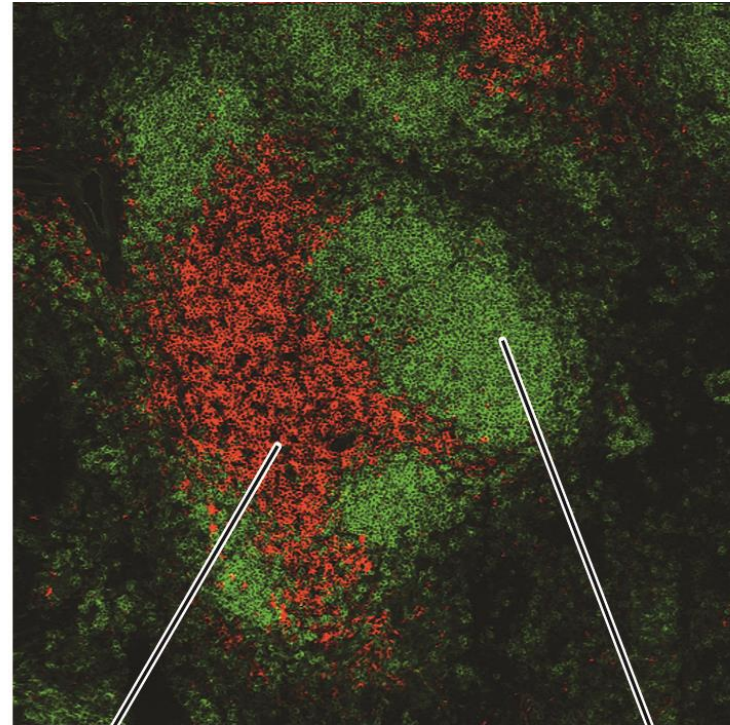


Morphology of the Spleen (2)



Periarteriolar
lymphoid
sheath(PALS)

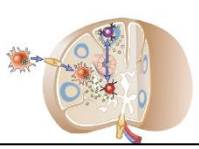
Germinal center
of lymphoid
follicle



T cell zone
(periarteriolar
lymphoid sheath)

B cell zone
(lymphoid follicle)

Fig. 2-16 B,C



The anatomical segregation of B and T lymphocytes in distinct areas of the nodes is dependant on cytokines that are secreted by lymph node stromal cells in each area and that direct the migration of the lymphocytes

Chemokines (chemoattractant cytokines)

Naïve T-Cells have a receptor CCR7 that binds chemokines CCL19 and CCL21 produced by the stroma cells in the T-cells zones.

Dendritic cells also express CCR7

Naïve B-cells express CXCR5 recognizes chemokine CXCL13 produced by FDCs (follicular dendritic cells)

Chemokine (C-C motif) receptor 7 (<http://www.ncbi.nlm.nih.gov/gene/1236>)

Chemokine (C-C motif) ligand 19

Chemokine (C-C motif) ligand 21

Chemokine (C-X-C motif) receptor 5

Chemokine (C-X-C motif) ligand