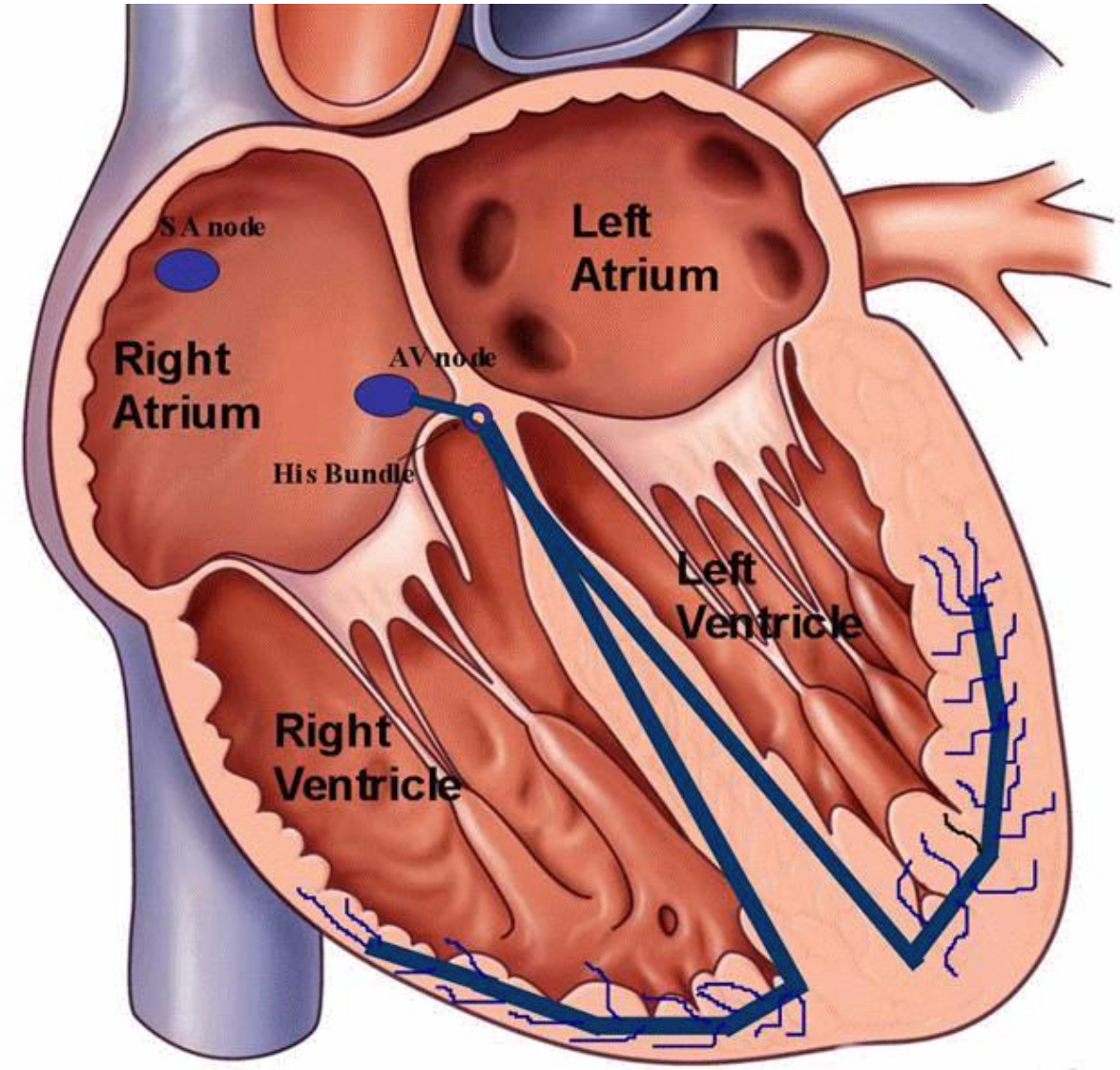
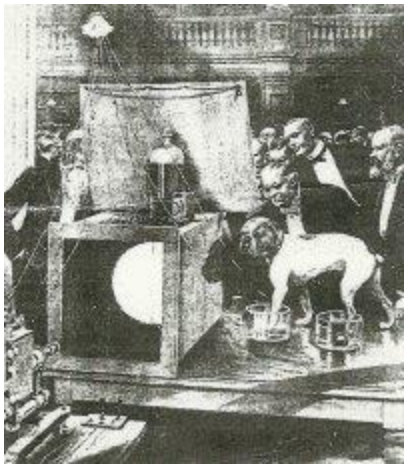
Curs 9

Sistemul cardiovascular (II)

Automatismul cardiac





Augustus Waller (1856-1922)

Willem Einthoven (1860-1927)

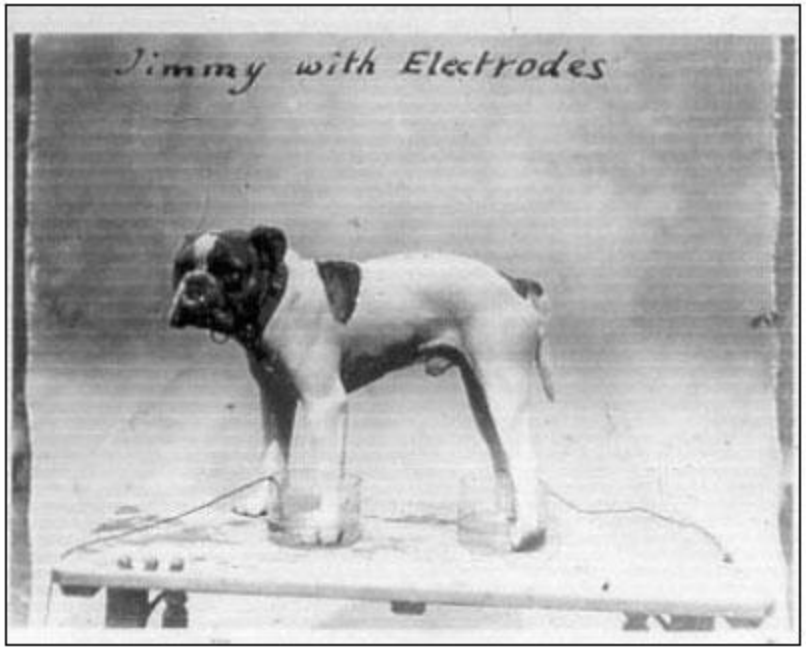
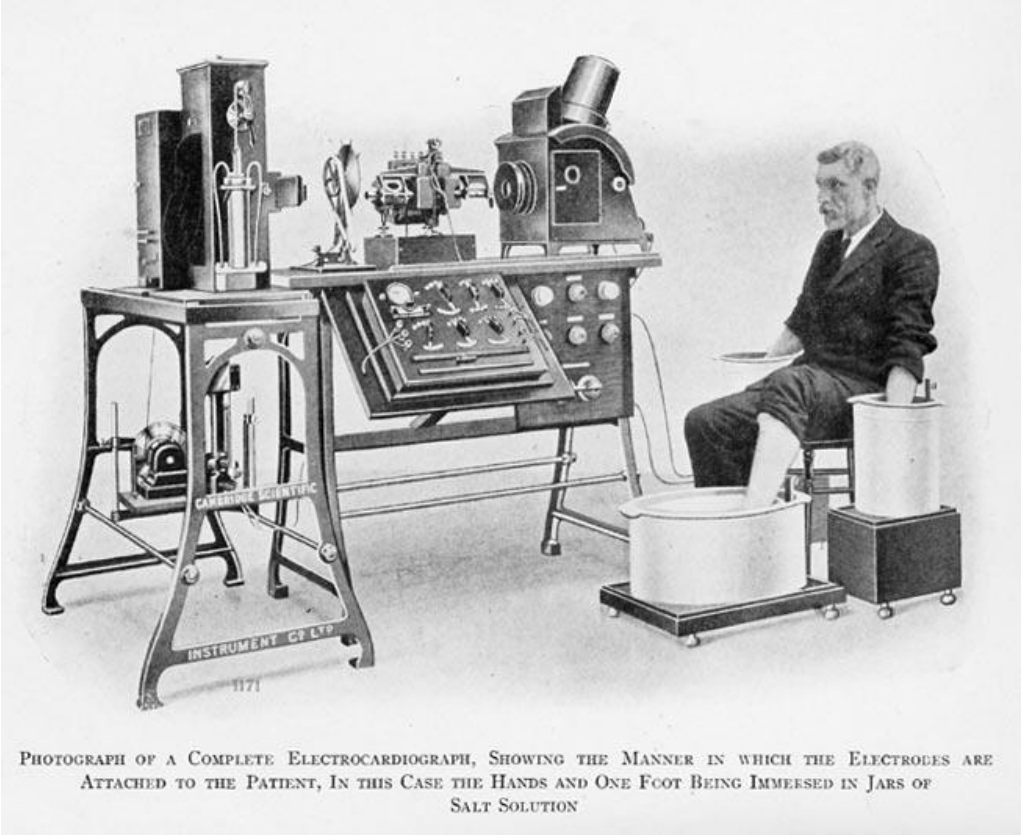
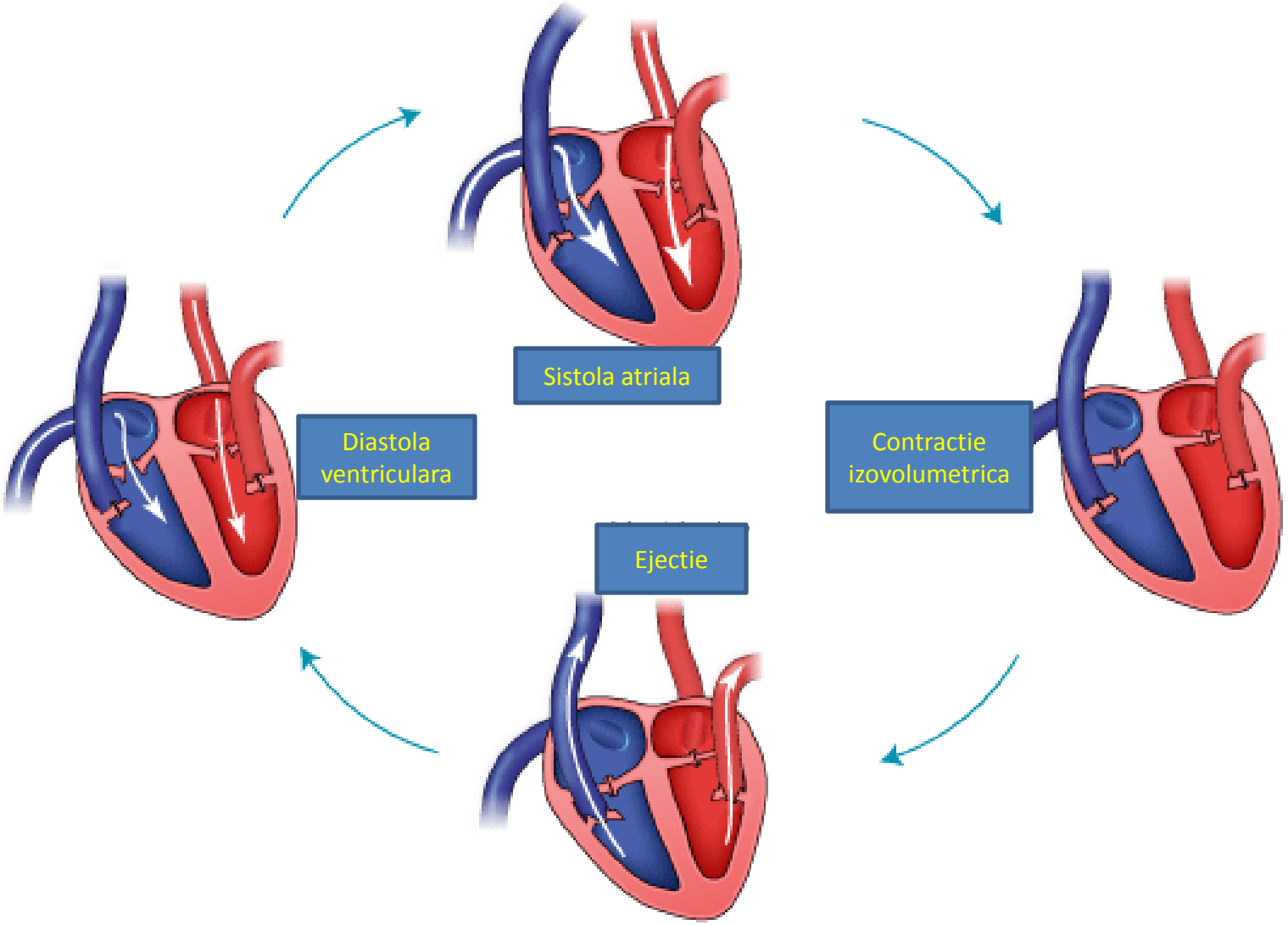


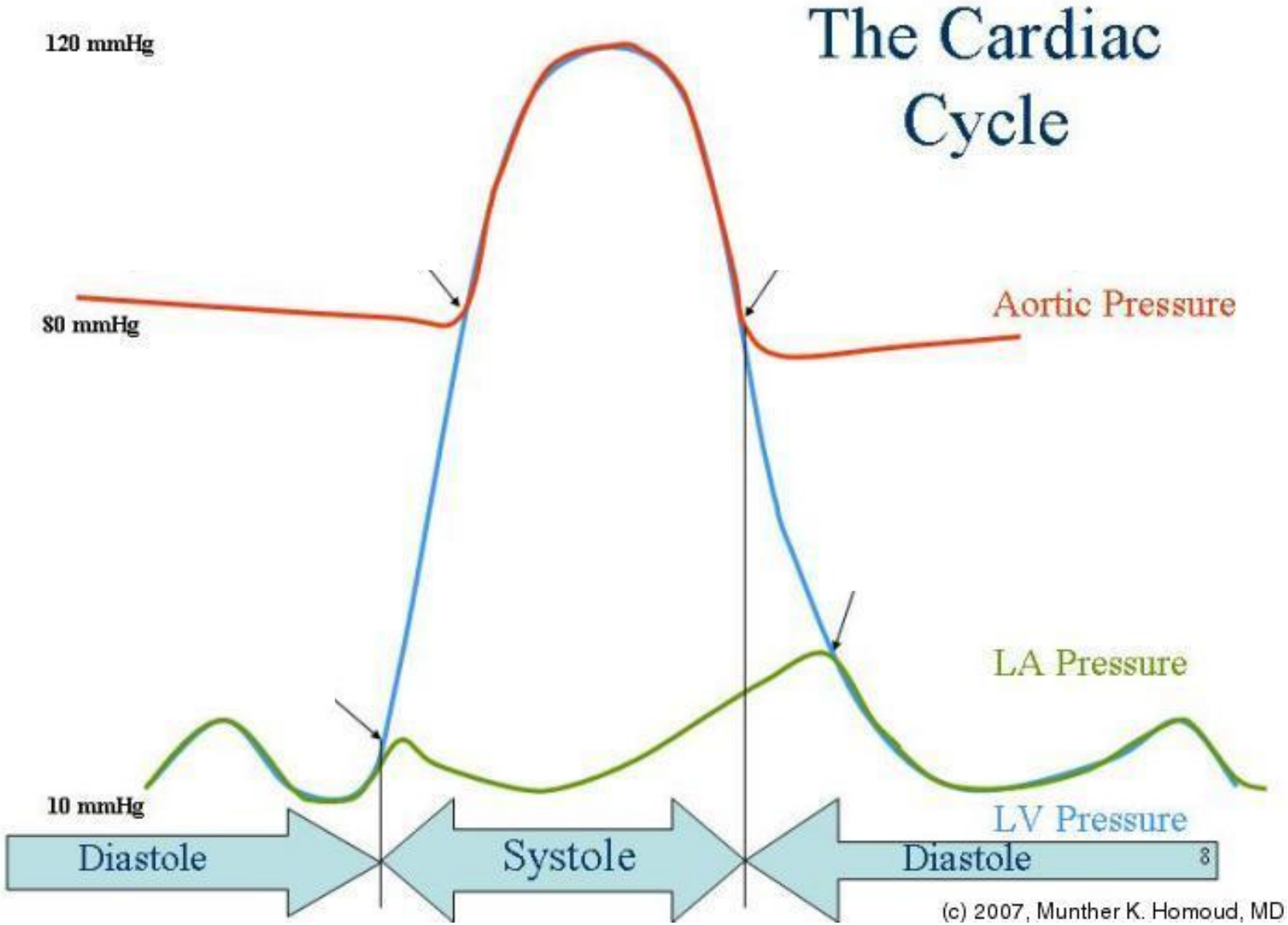
Fig. 3: Waller's dog, Jimmy, connected for electrogram with feet in saline.



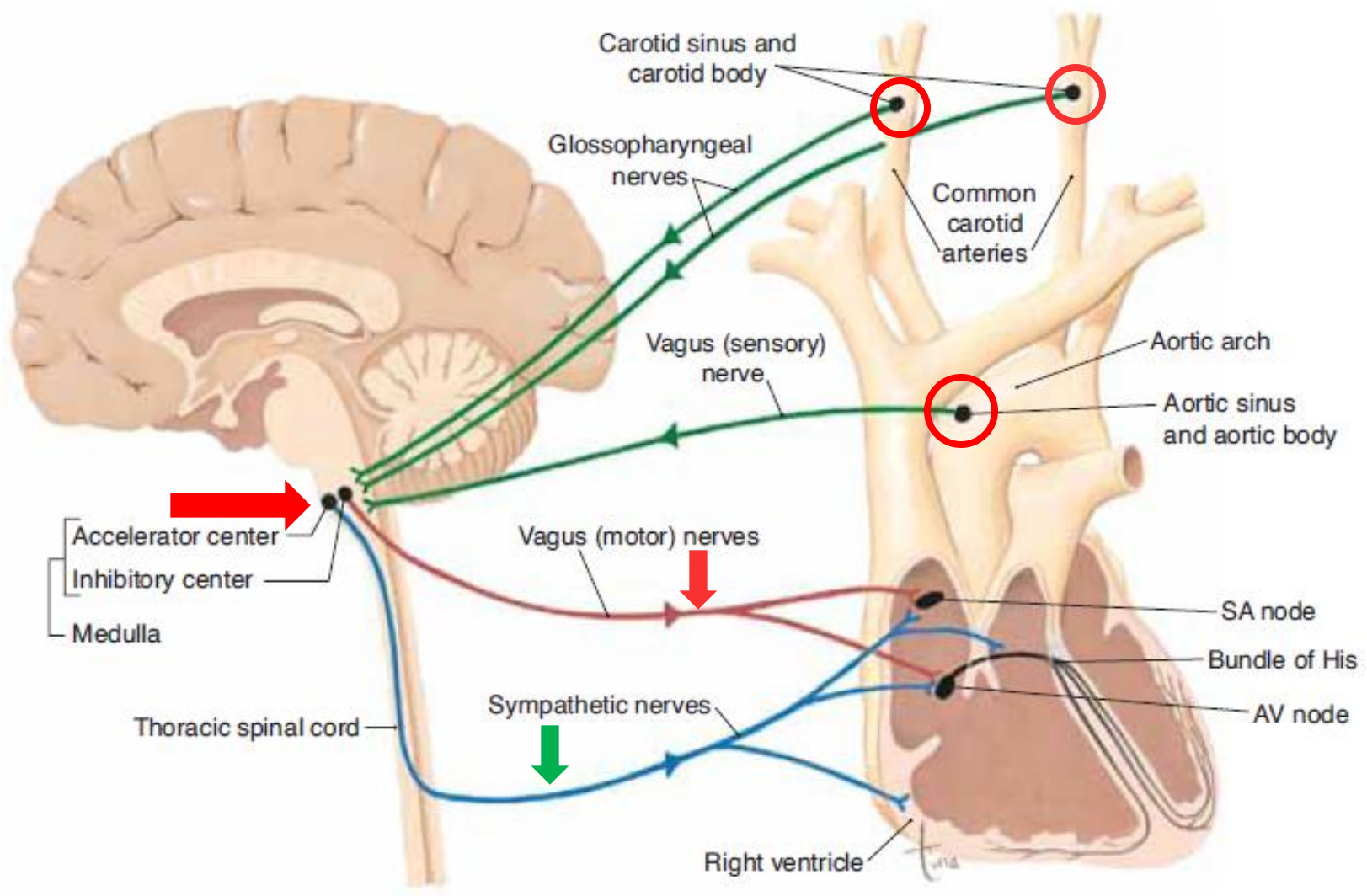
Photograph of a Complete Electrocardiograph, Showing the Manner in which the Electrodes are Attached to the Patient, In this Case the Hands and One Foot Being Immersed in Jars of Salt Solution

Ciclul cardiac

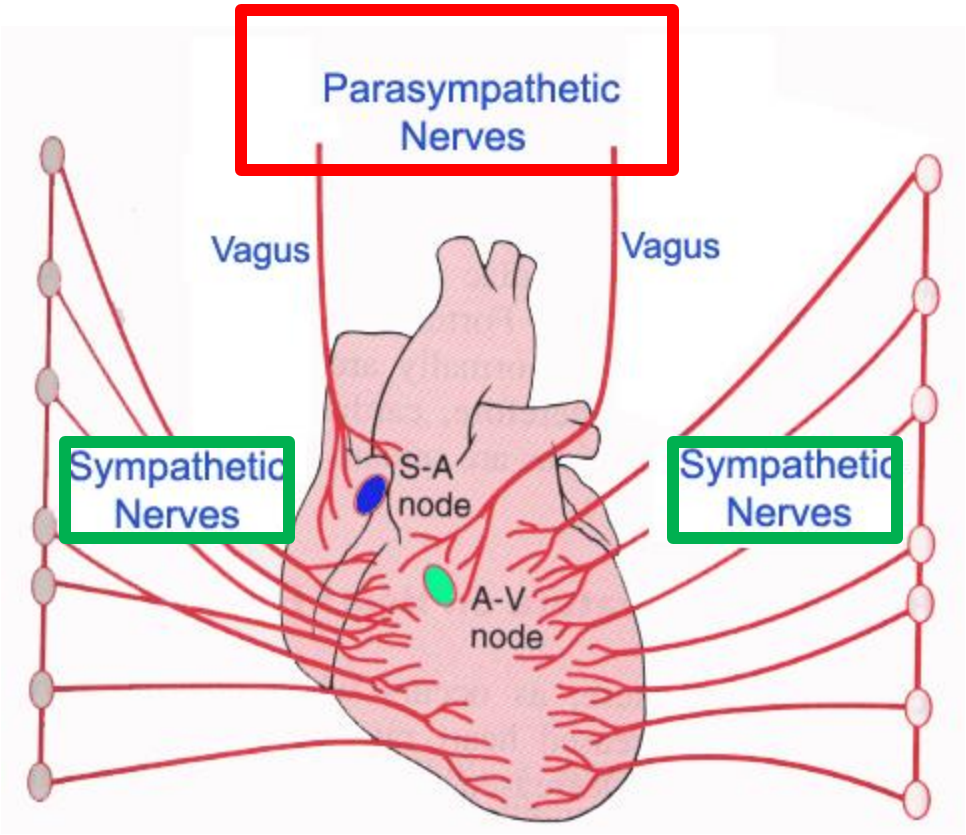



The Cardiac Cycle
120 mmHg
80 mmHg
10 mmHg
Aortic Pressure
LA Pressure
LV Pressure
Diastole
Systole
Diastole
8
(c) 2007, Munther K. Homoud, MD

Controlul autonom al inimii

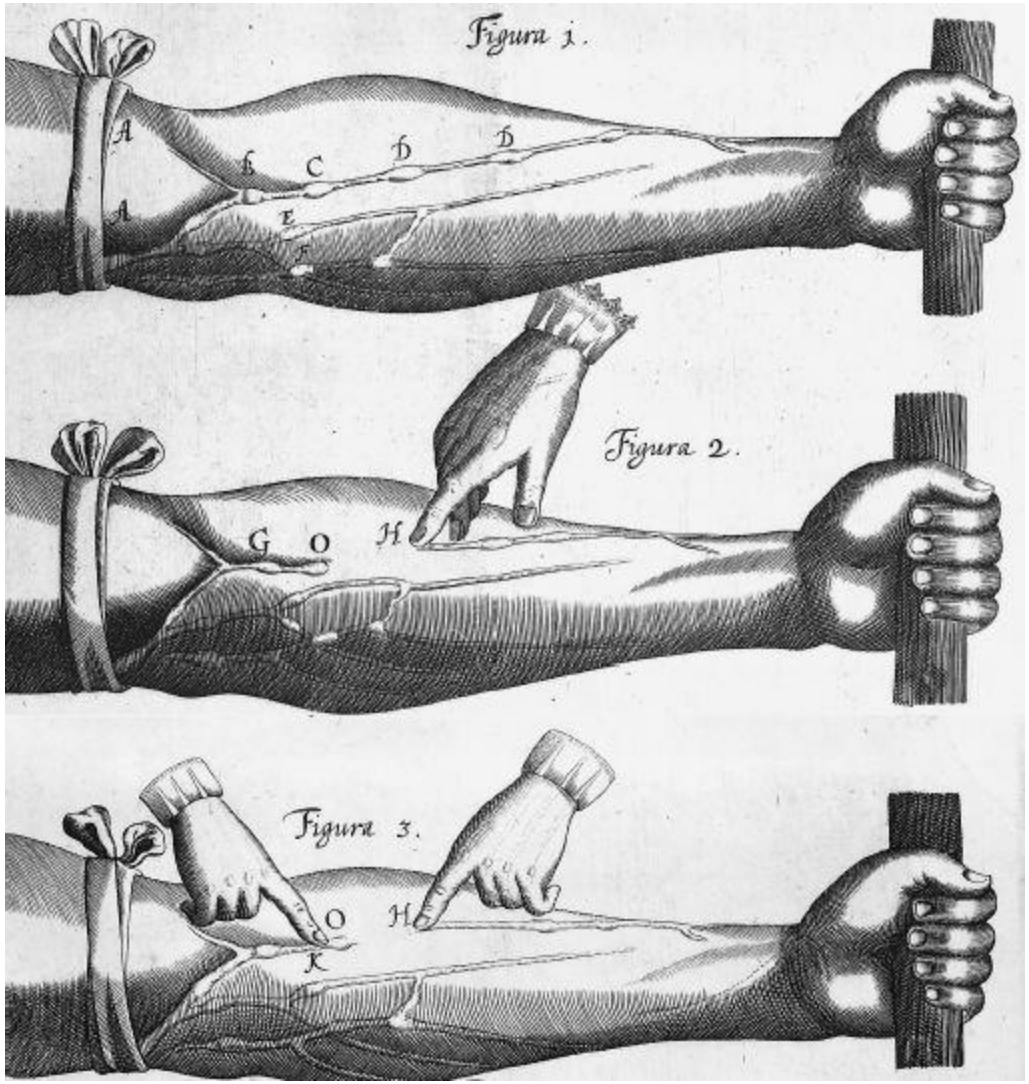


Controlul autonom al inimii

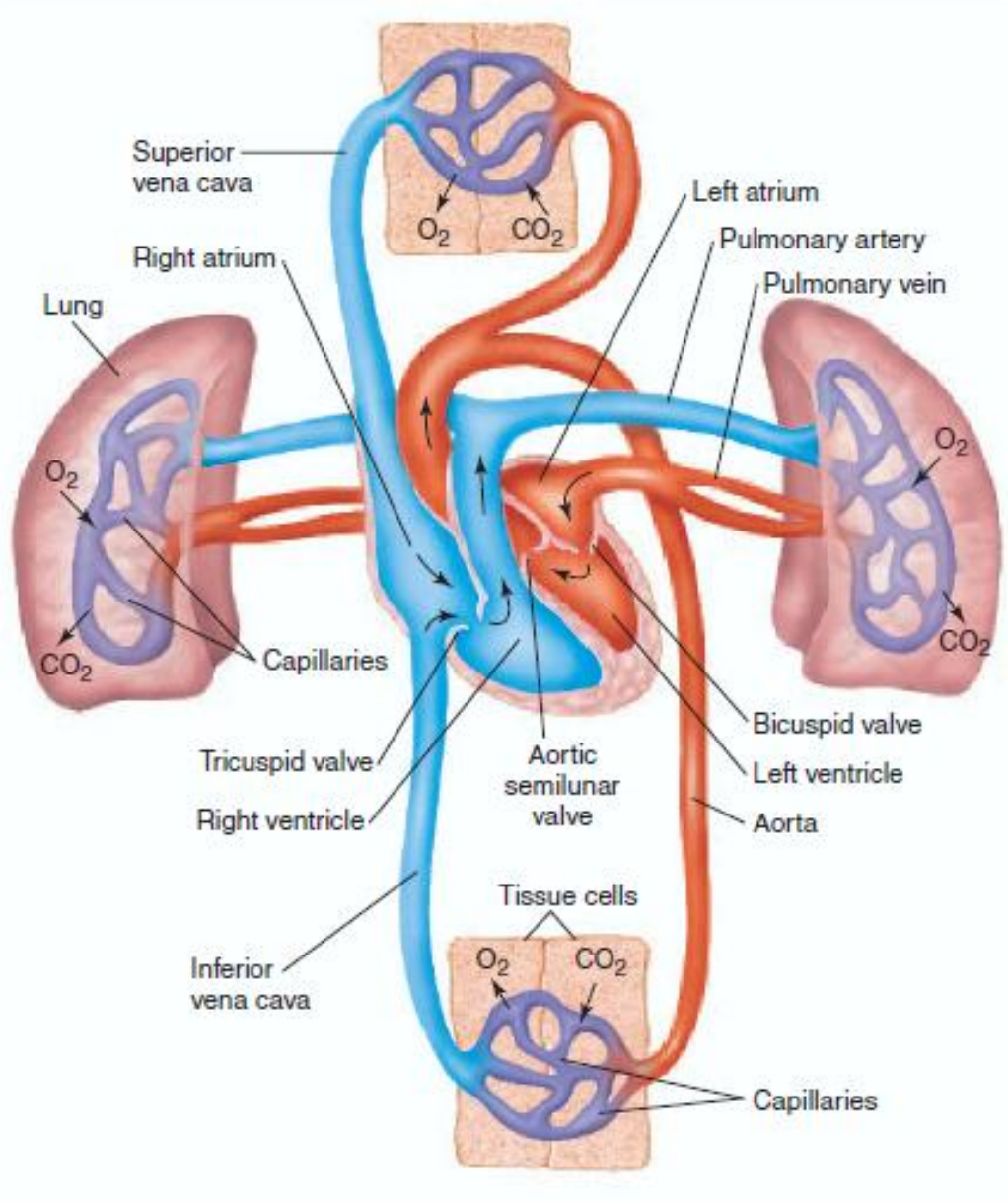


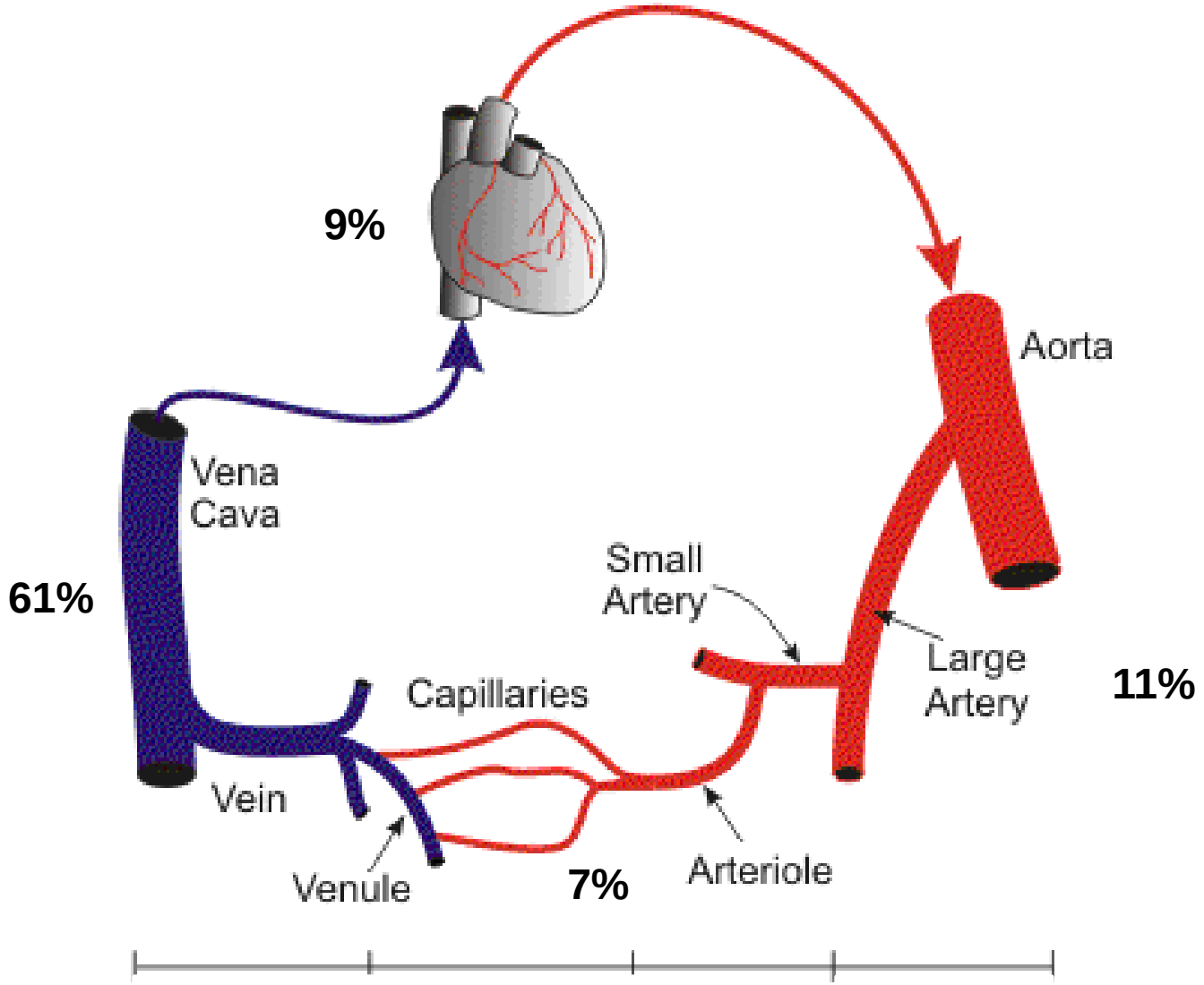
Sistemul circulator – vasele de sange

William Harvey (1578 – 1657)



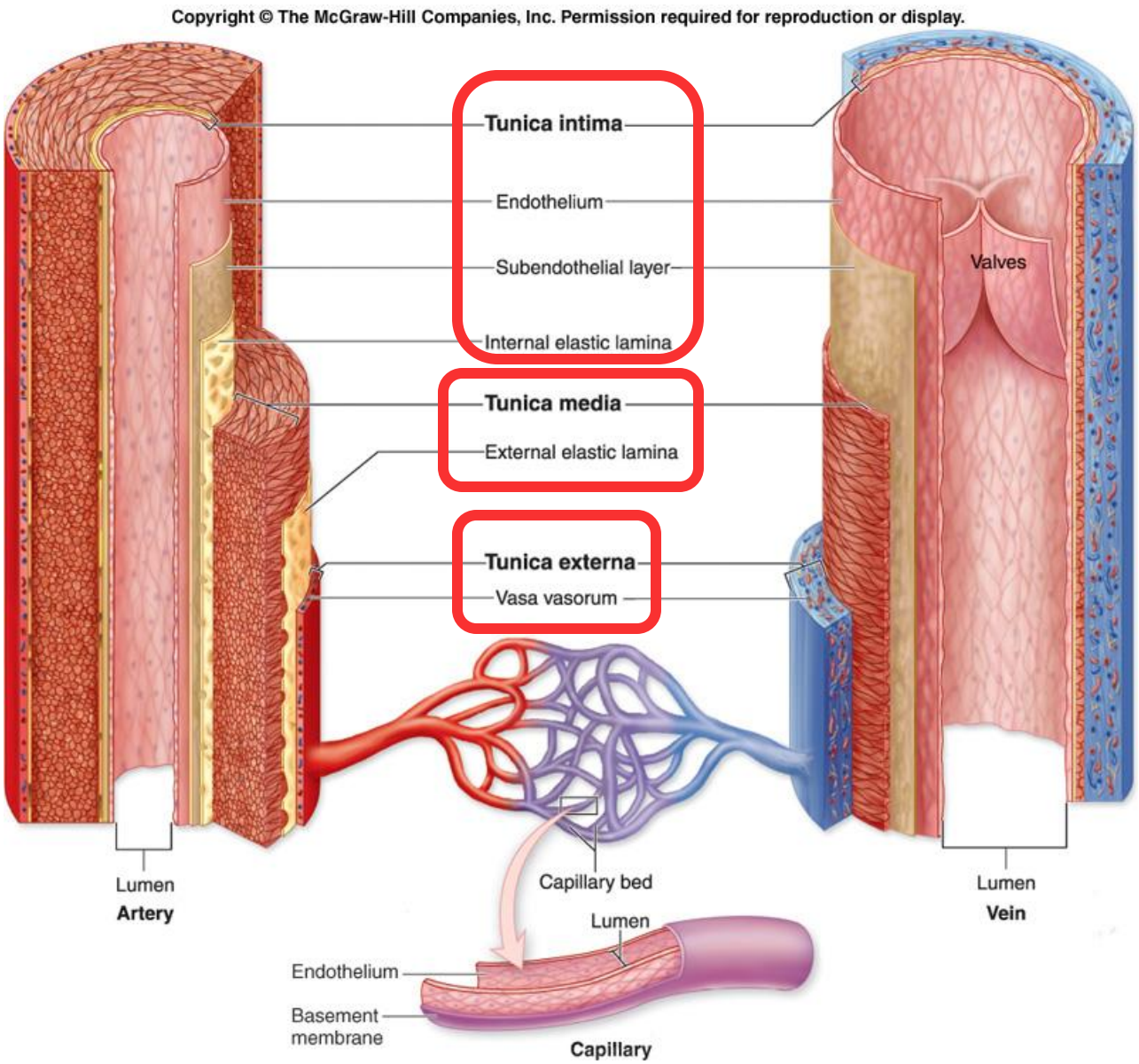
Schema generala a circulatiei





12% in circ. pulmonara

Structura vaselor de sange



	Mean diameter	Mean wall thickness	Endothelium	Elastic tissue	Smooth muscle	Fibrous tissue	
Artery	4.0 mm	1.0 mm					
Arteriole	30.0 µm	6.0 µm					
Capillary	8.0 µm	0.5 µm					
Venule	20.0 µm	1.0 µm					
Vein	5.0 mm	0.5 mm					

Fig. 15.2

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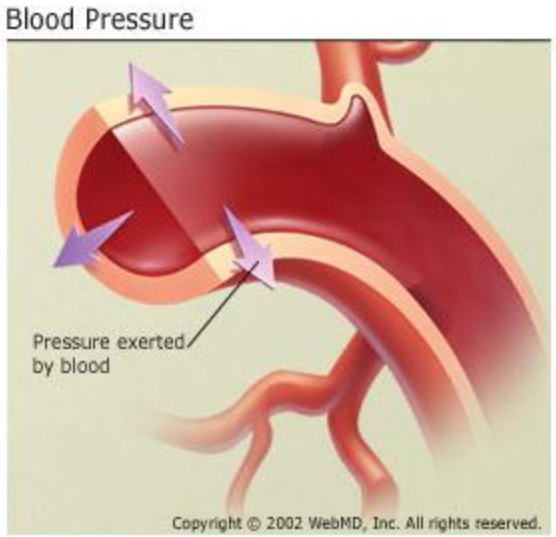
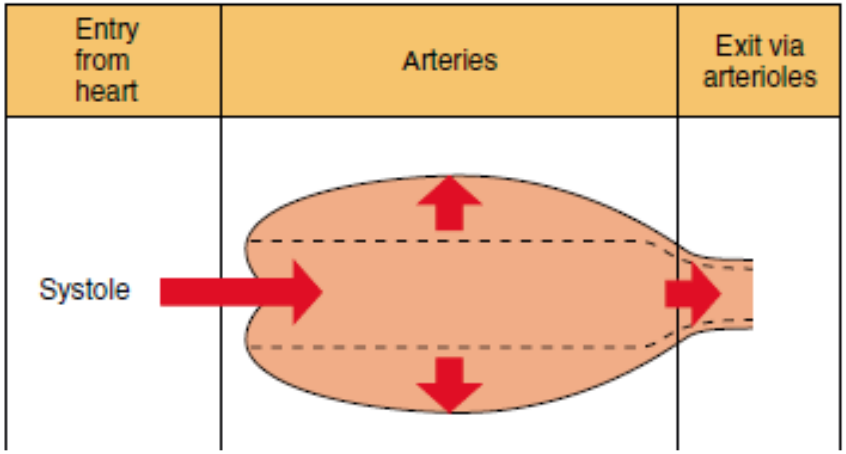
Presiunea sangelui (tensiunea)





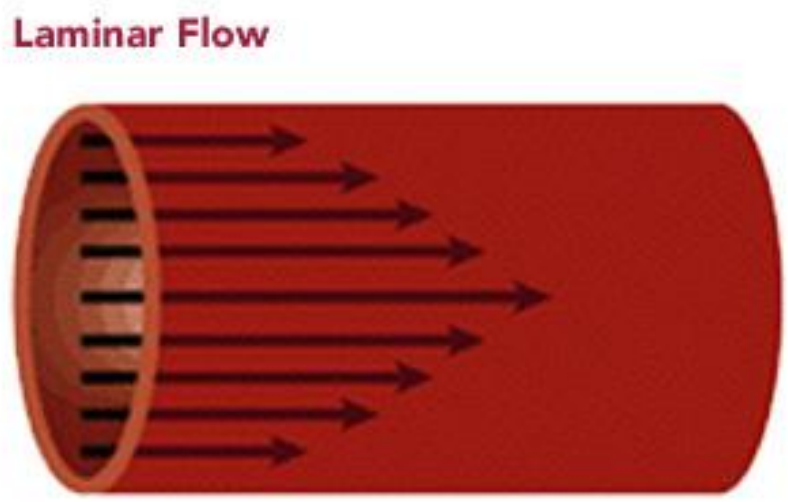
Volumul de sange ejectat in timpul sistolei destinde peretii arteriali

Reculul elastic al acestora in timpul diastolei propulseaza sangele in circulatie

$$\boxed{PAM = P_{diastolica} + 1/3 \times P_{puls} = P_{diast} + 1/3\,(P_{sist} - P_{diast})}$$

Relatia dintre flux, presiune si rezistenta

$F\ (flux) = \Delta p/R$

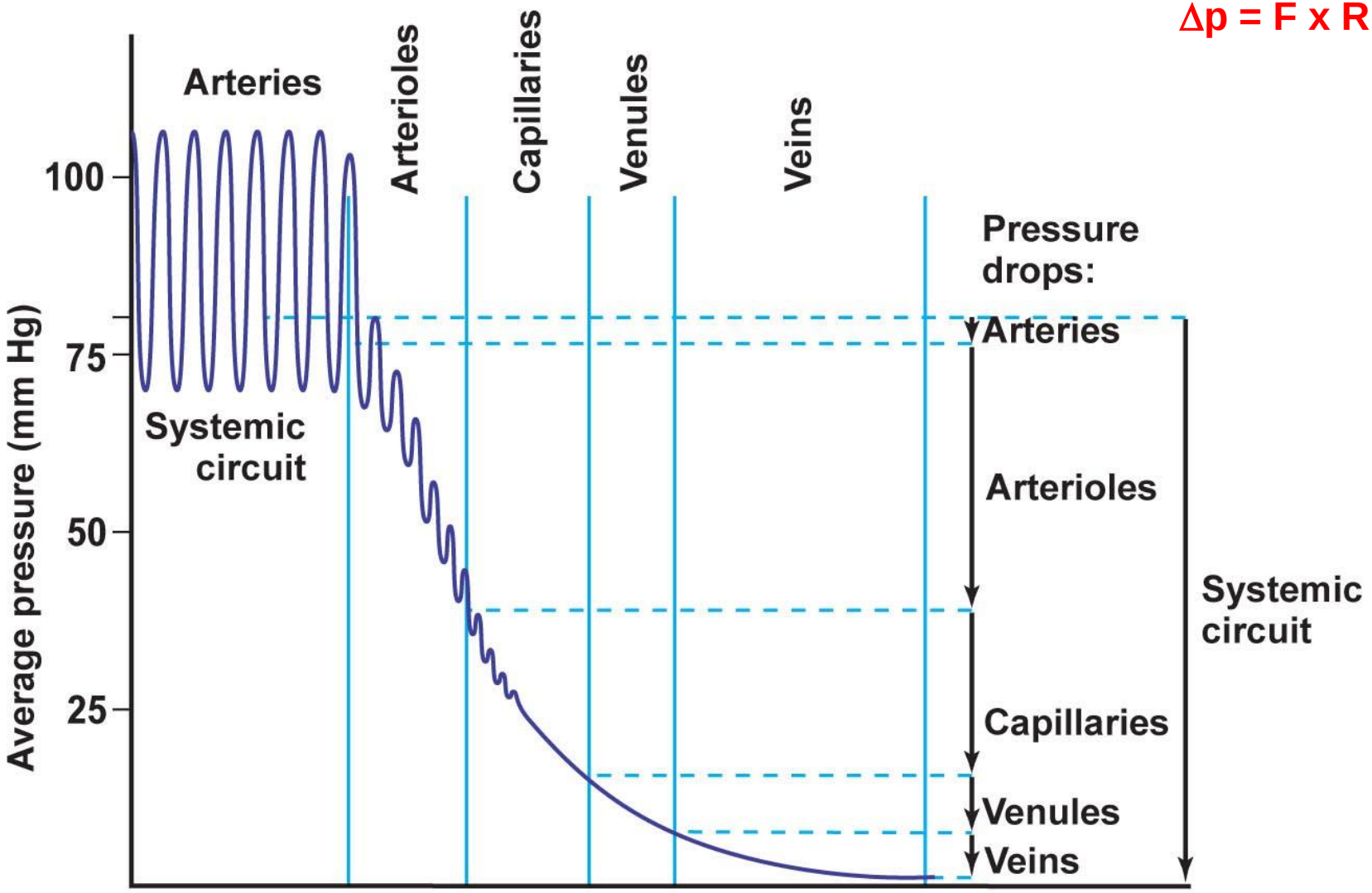


P1 P2

$\Delta p = F \times R$ → $(PAM - P_{atriu\ stang}) = OC \times RP$ → **PAM = OC x RP**

Presiunea sangvina in circulatia sistemica

$\Delta p = F \times R$



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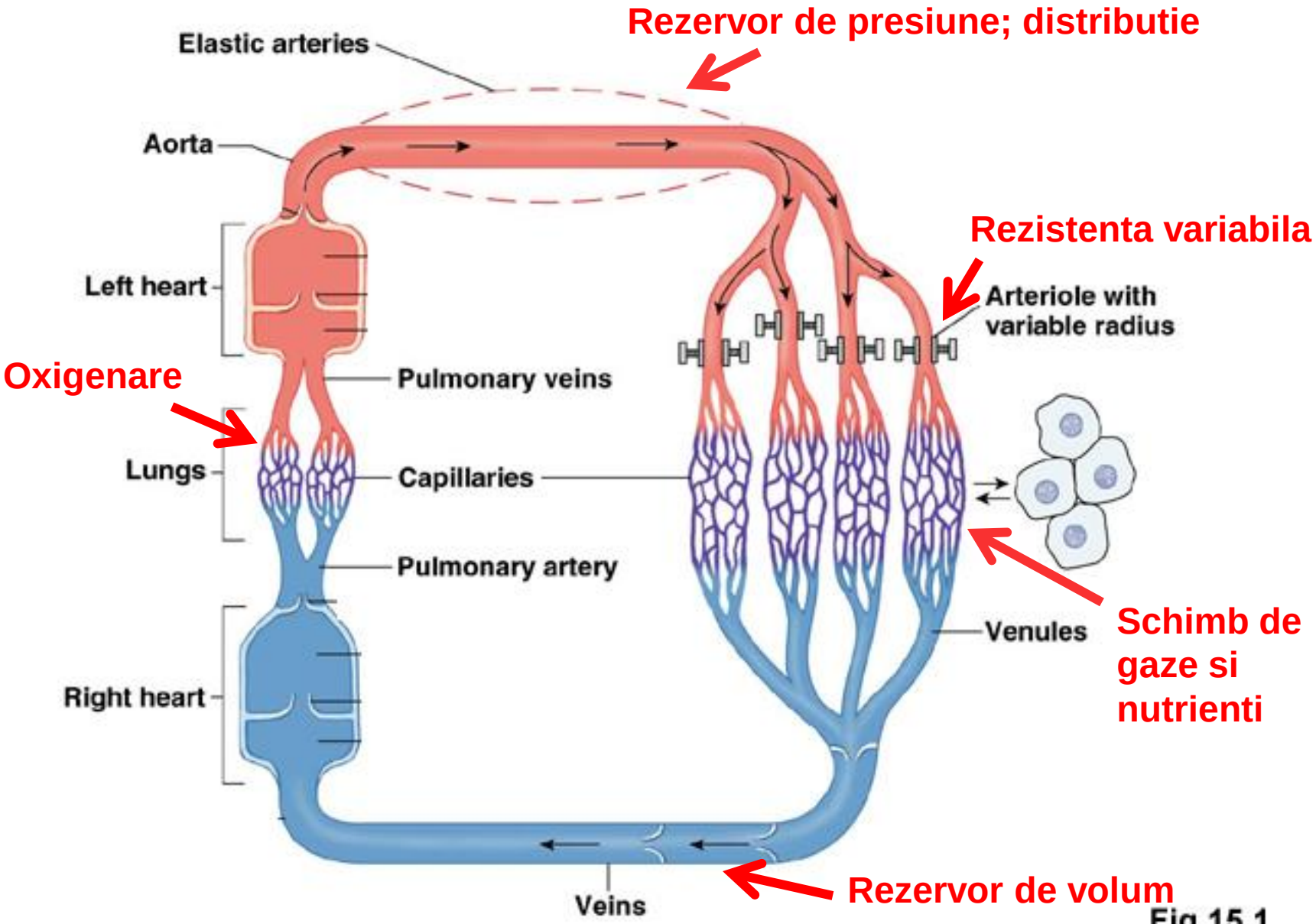

Fig 15.1

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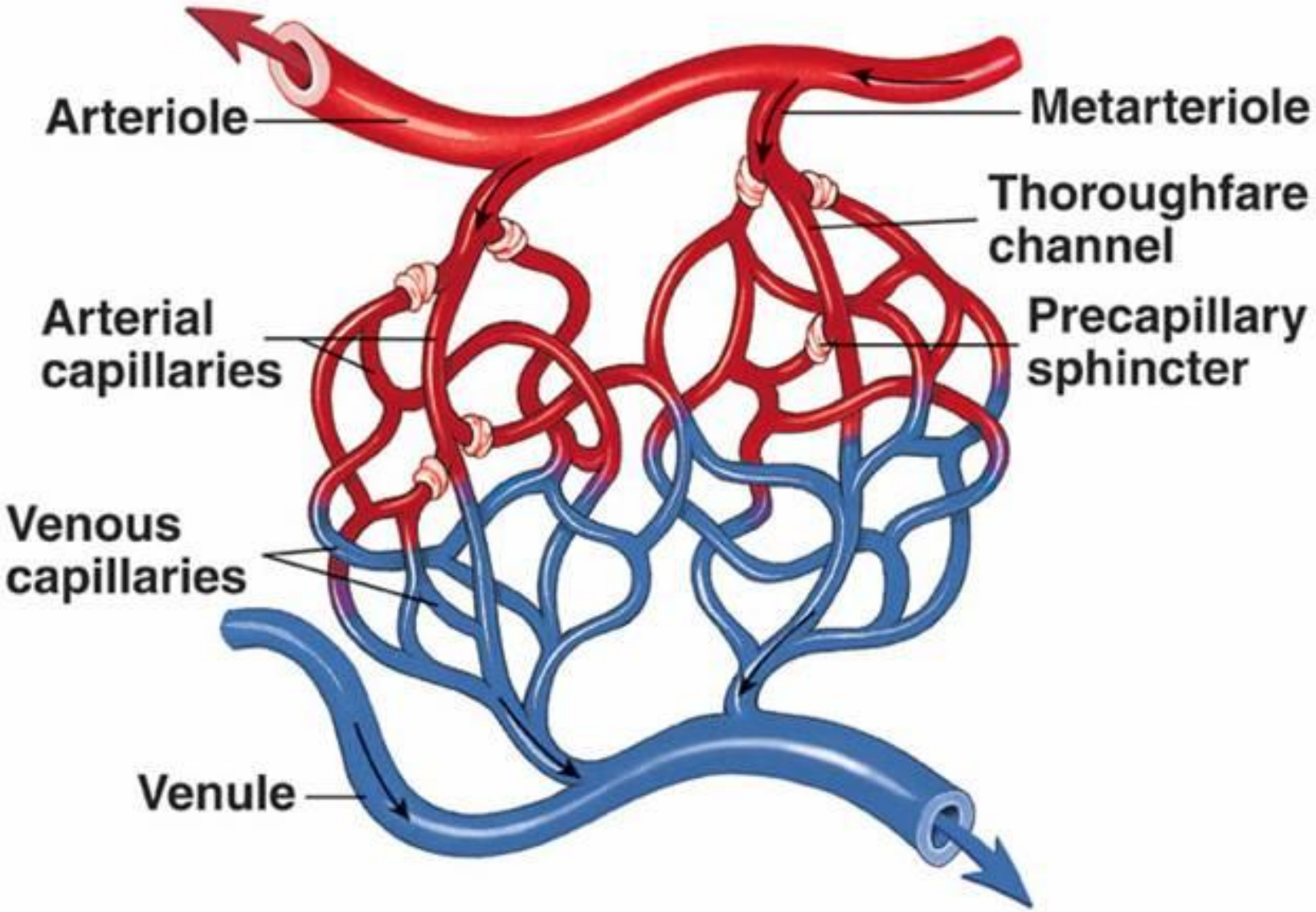
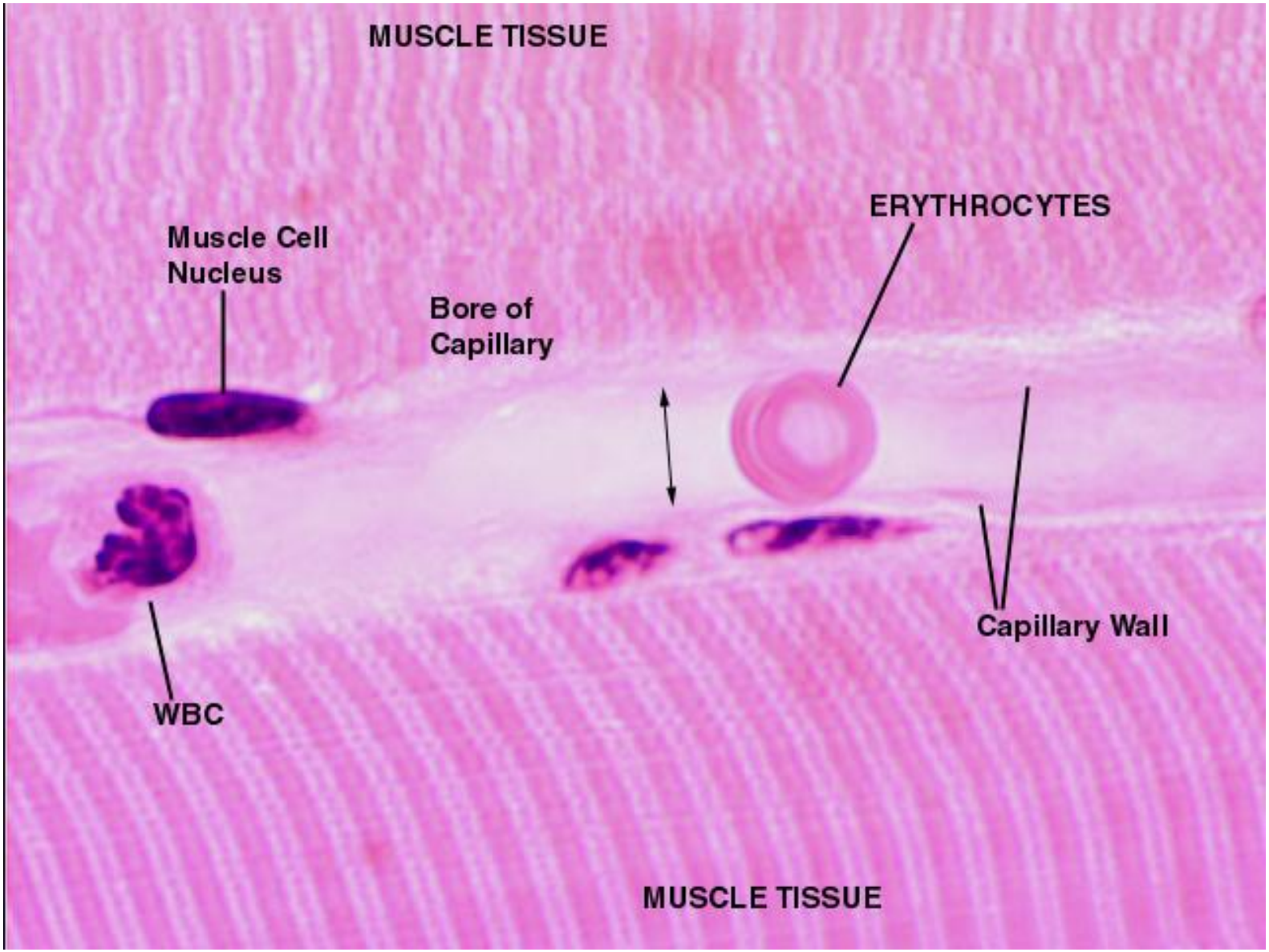
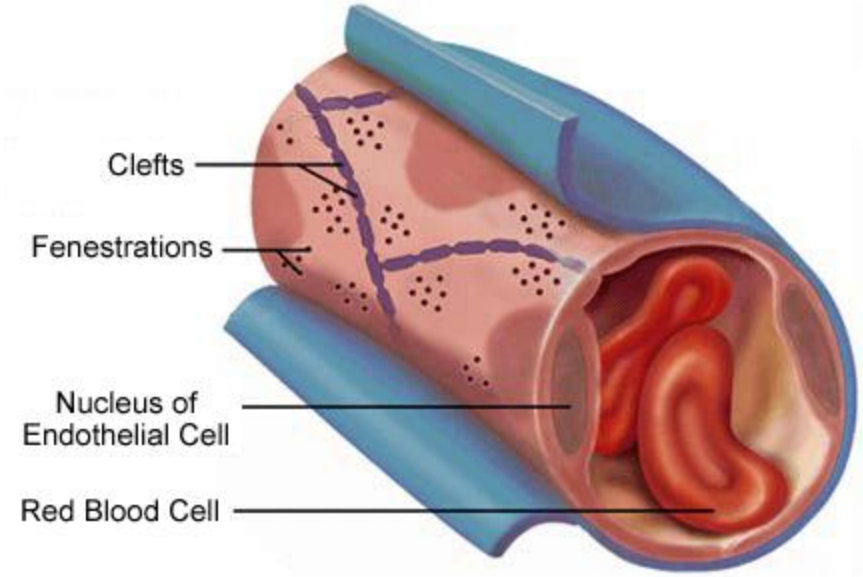
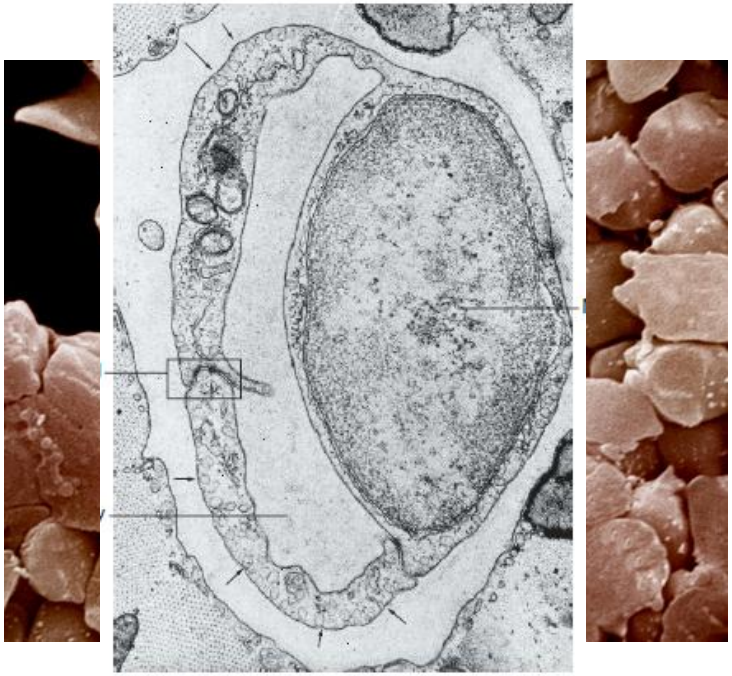


Vas capilar in muschiul scheletic

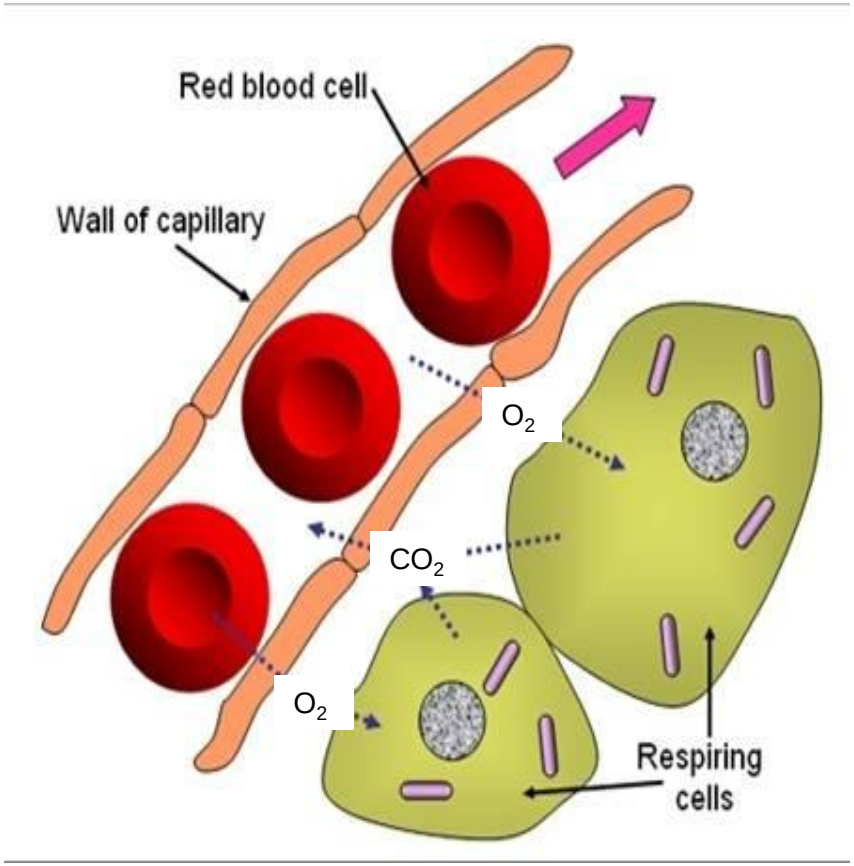


Capilarele – schimbul de gaze, nutrienti, produsi metabolici

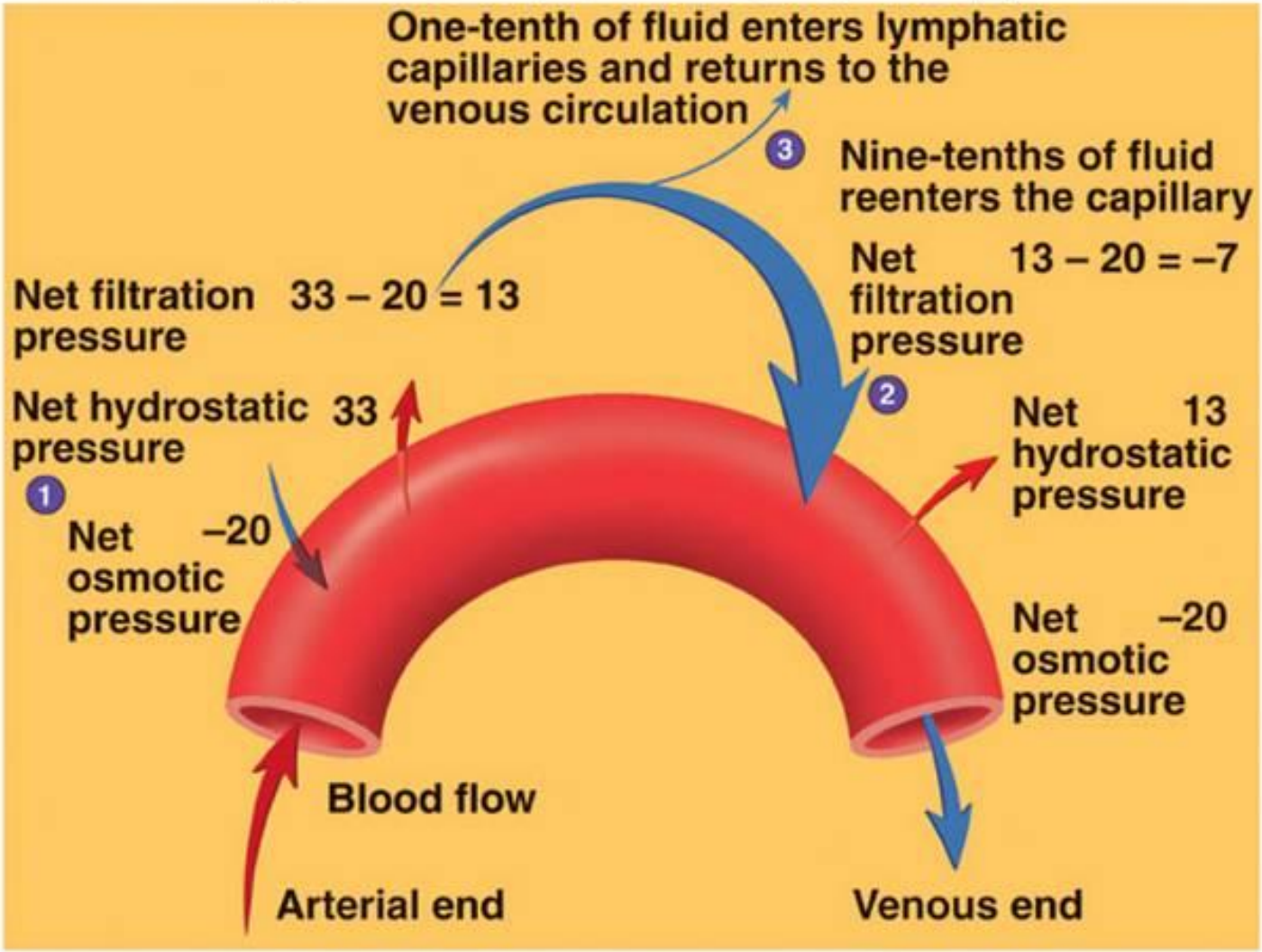




Difuzia O_2 si CO_2



Filtrarea si reabsorbtia fluidului prin peretele capilarelor – fortele Starling



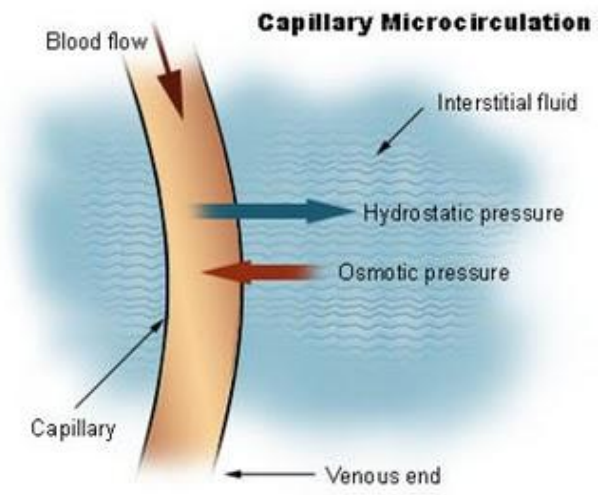
Filtrarea si reabsorbtia fluidului prin peretele capilarelor – fortele Starling

Forte care produc filtrarea

1. Presiunea sangvina (presiunea hidrostatica din capilarii) – P_C
2. Presiunea osmotica a fluidului interstitial - Π_{IF}

Forte care produc reabsorbtia

1. Presiunea hidrostaica a fluidului interstitial – P_{IF}
2. Presiunea osmotica a plasmei sangvine - Π_C



$$\text{Presiunea totala de filtrare} = P_{tot} = P_C + \Pi_{IF} - P_{IF} - \Pi_C$$

La capatul **arterial** al capilarelor – $P_{tot} = 33 + 5 - 0 - 25 = 13$ mm Hg - **filtrare**

La capatul **venos** al capilarelor – $P_{tot} = 13 + 5 - 0 - 25 = -7$ mm Hg - **reabsorbtie**

In total cca. 90% din fluidul filtrat la capatul arterial este reabsorbit la cel venos; Restul de 10% este preluat de sistemul limfatic

Sistemul limfatic – filtrare neta – 4l/zi

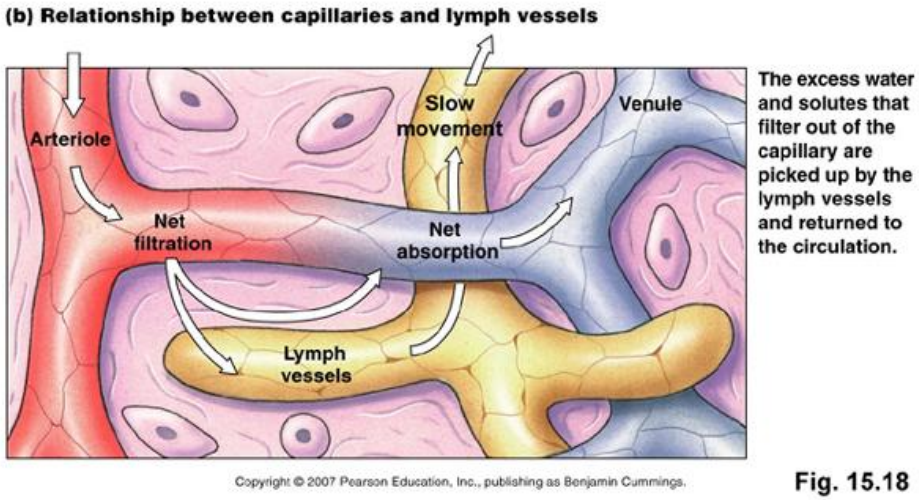
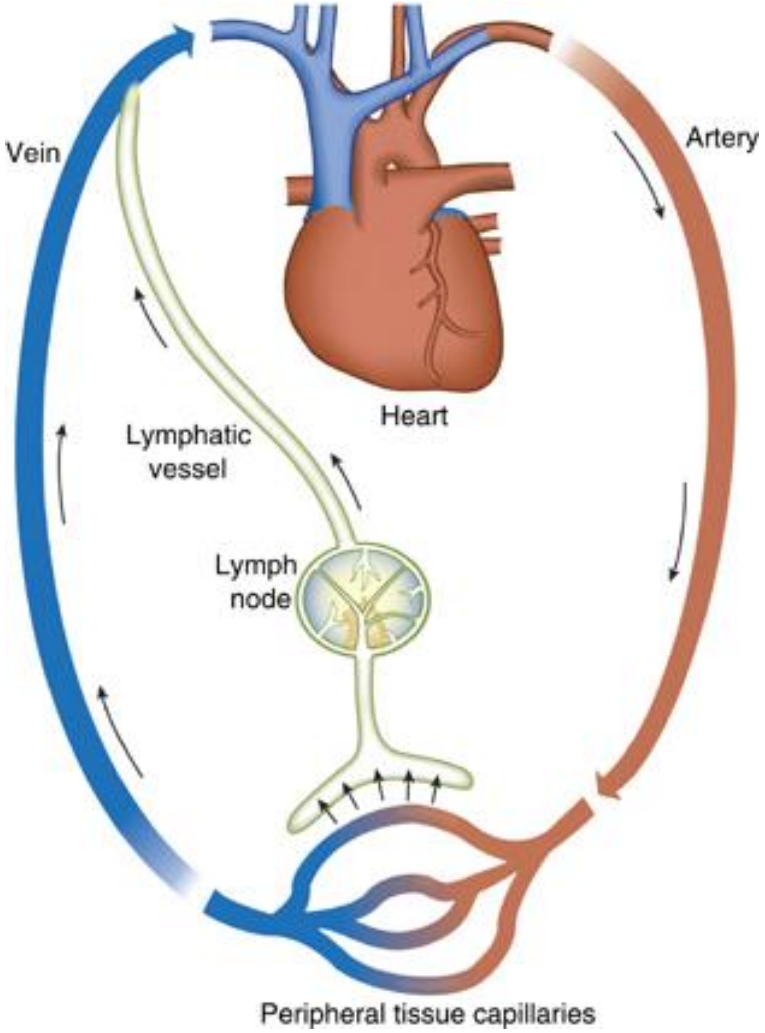


Fig. 15.18

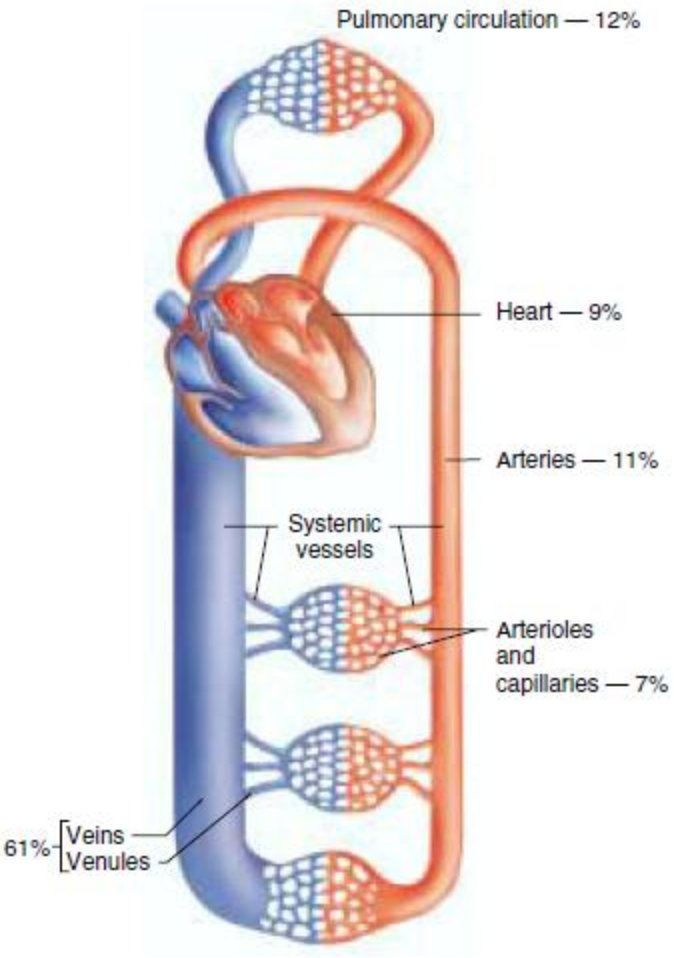


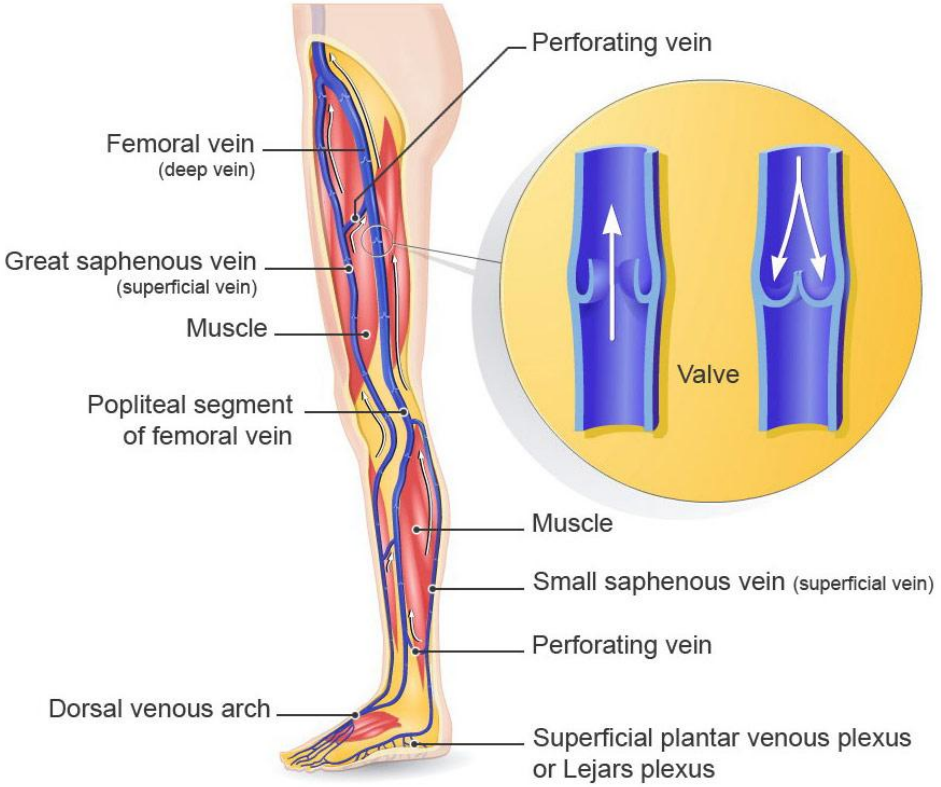
Edem – acumularea de fluid in spatiul interstitial

Blocarea vaselor limfatice – **elefantiazis (nematode Filarioidea)**

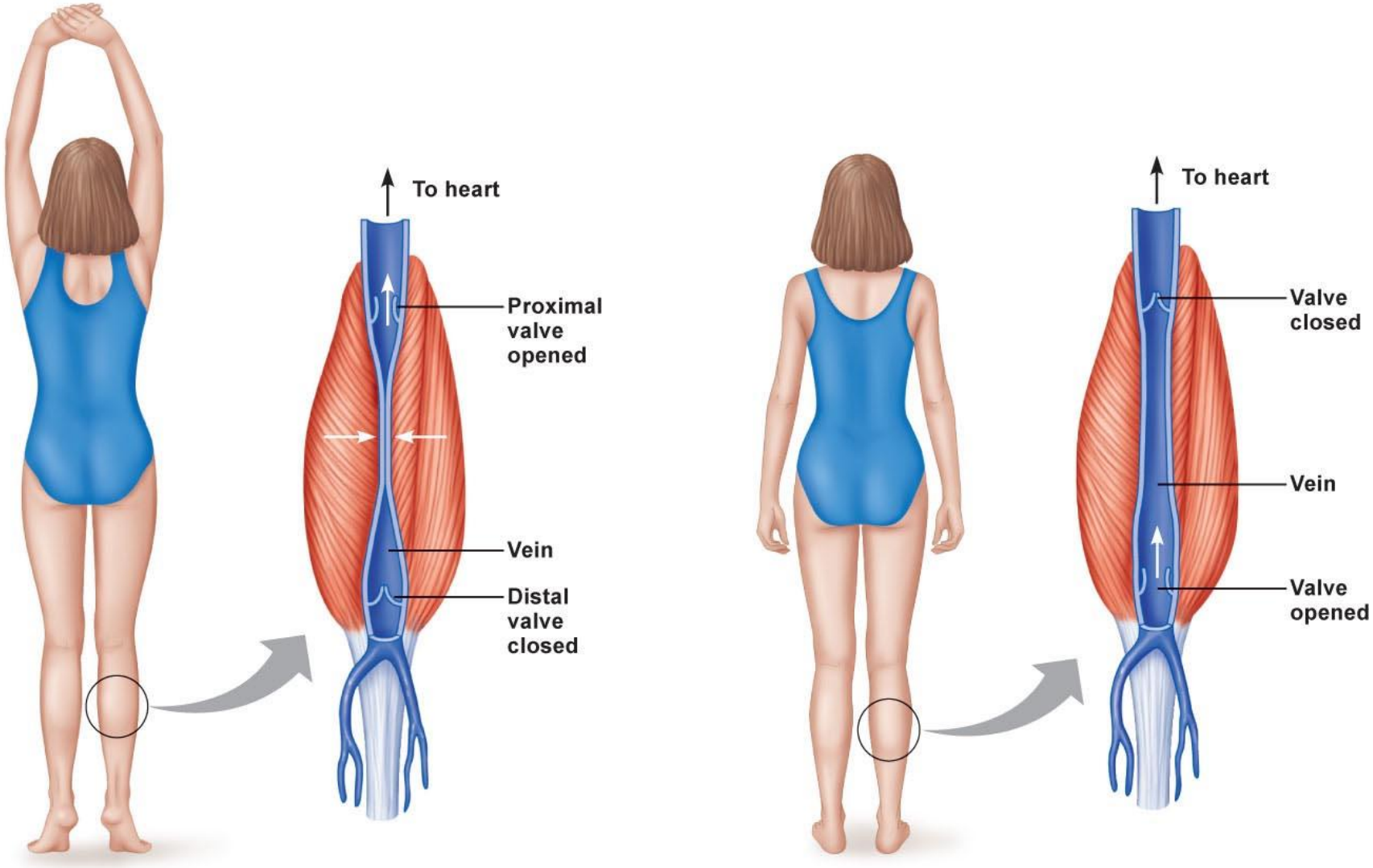
Scaderea presiunii osmotice a plasmei
– scaderea nivelului de proteine plasmatice din cauza **malnutritiei, cirozei hepatice**

Sistemul venos – rezervor de volum; valvele venoase





Sistemul venos – pompa musculara



(a) Skeletal muscle contracted

(b) Skeletal muscle relaxed

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Reglarea presiunii arteriale

1. Mecanisme locale de reglare a presiunii arteriale

1. Hiperemia activa
2. Autoreglarea fluxului

2. Sistemul nervos simpatic

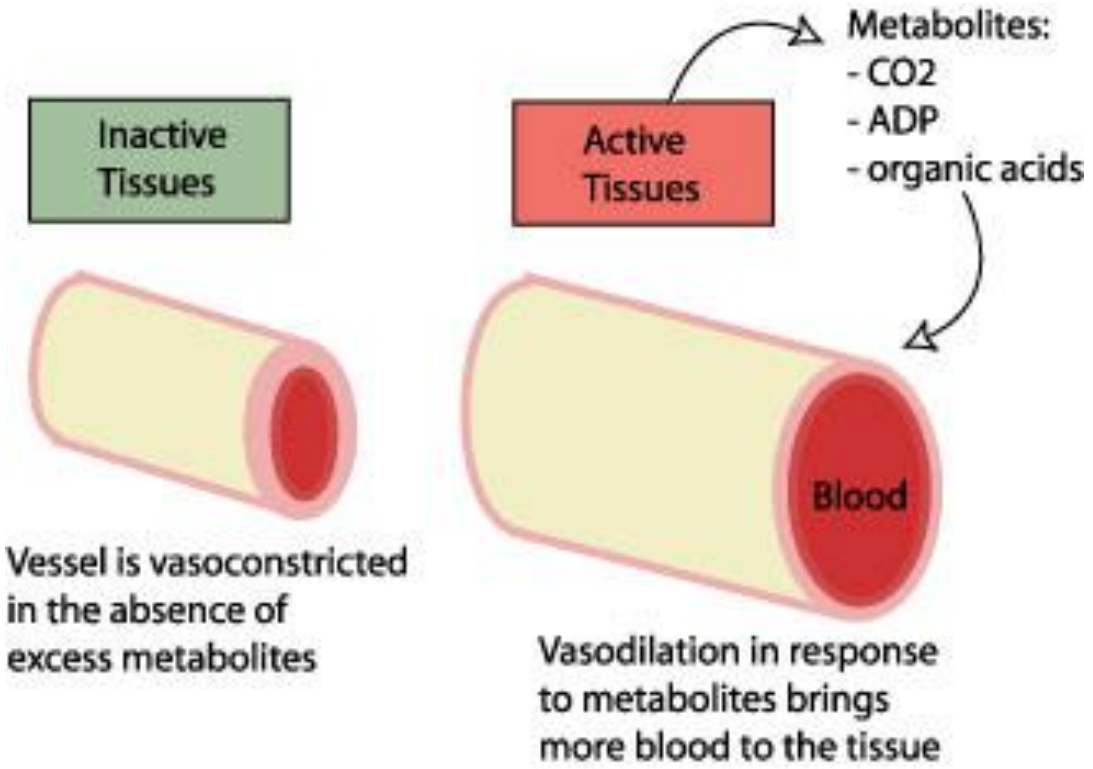
3. Hormoni

- vasoconstrictie: ADH, adrenalina, noradrenalina, angiotensina II
-vasodilatare: bradikinina, prostaciclina, ANP (peptida atriala natriuretica), adrenalina (doar in muschiul cardiac si scheletic)

PAM (pres. Arteriala medie) = OC (output cardiac) x RP (rezistenta periferica)

Hiperemia activa

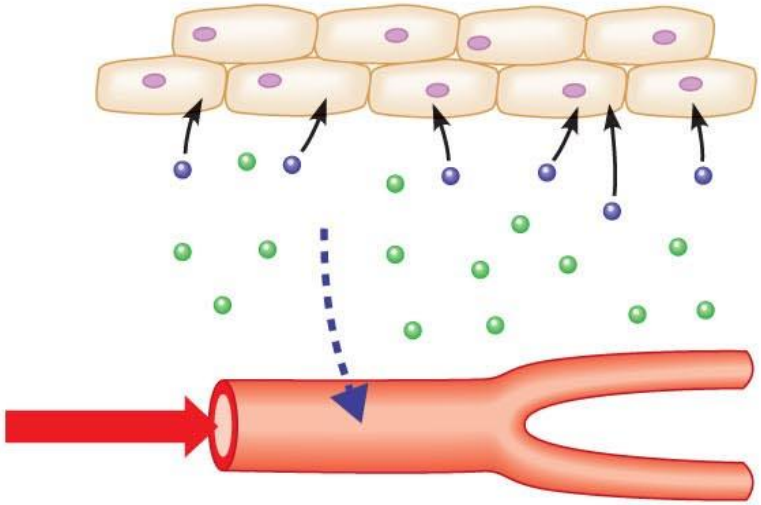
- alterarea diametrului arteriolar in functie de nevoile metabolice ale tesutului
- Tesutul activ metabolic elibereaza CO_2, H^+, adenozina, K^+, bradikinina, NO – **vasodilatatori (relaxarea muschiului neted)**



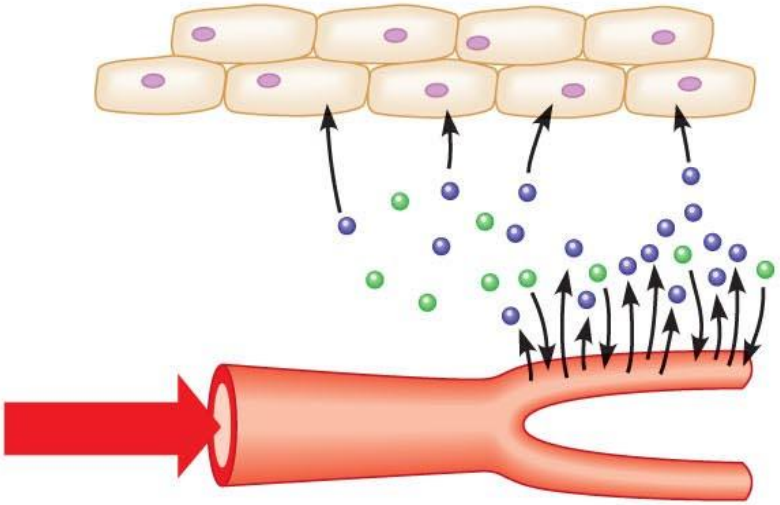
Autoreglarea fluxului

- alterarea diametrului arteriolar ca raspuns la variatiile fluxului sangvin in tesutul respectiv

Hiperemie activa



(c) The decreased oxygen concentration and increased carbon dioxide concentration act on arteriolar smooth muscle to promote vasodilation.



(d) Vasodilation promotes increased blood flow, which increases oxygen delivery to cells and carbon dioxide removal from cells.

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removed from tissues by the blood as fast as it is produced by cells.

oxygen concentration in extracellular fluid decreases, while carbon dioxide concentration increases.

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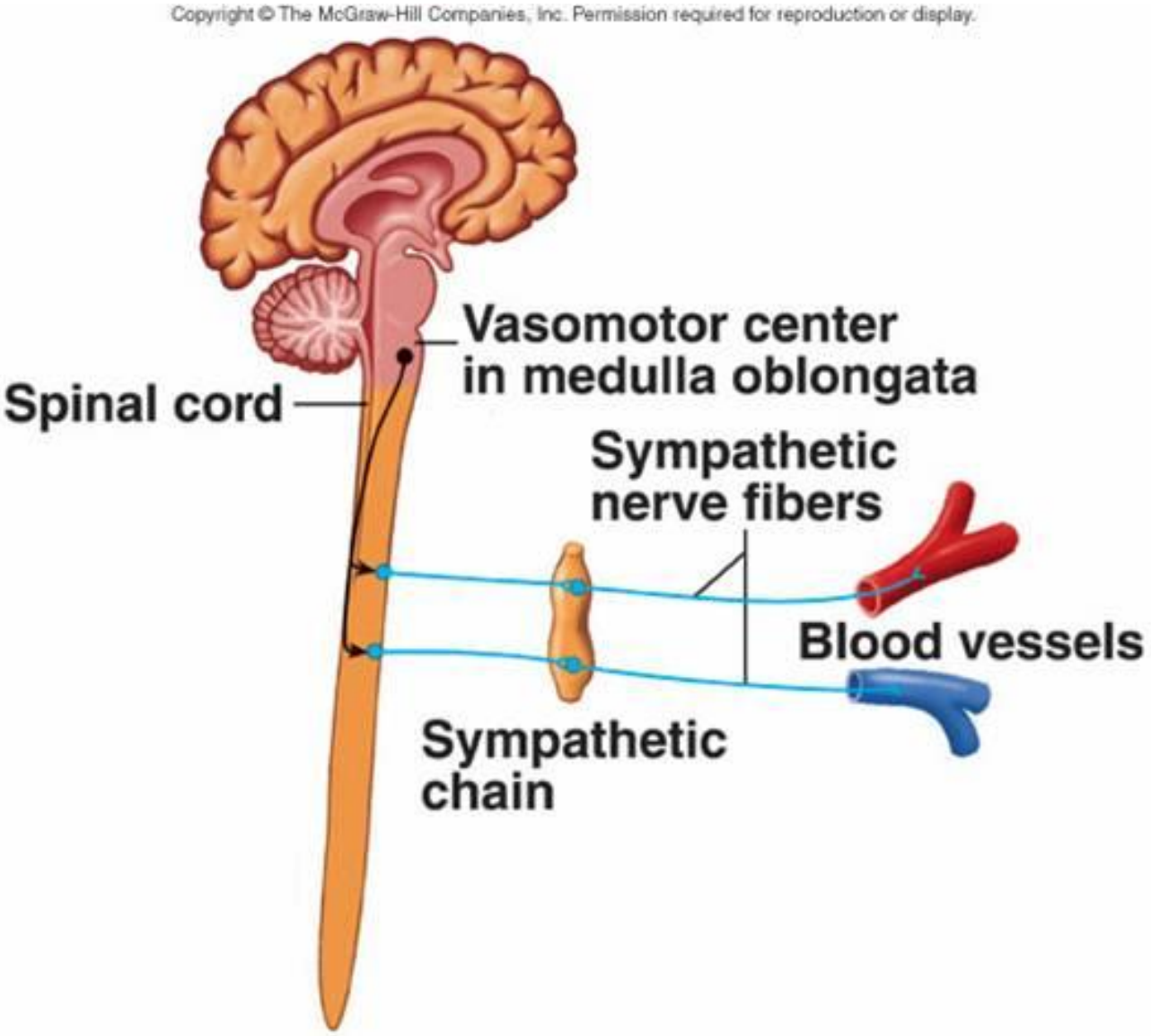
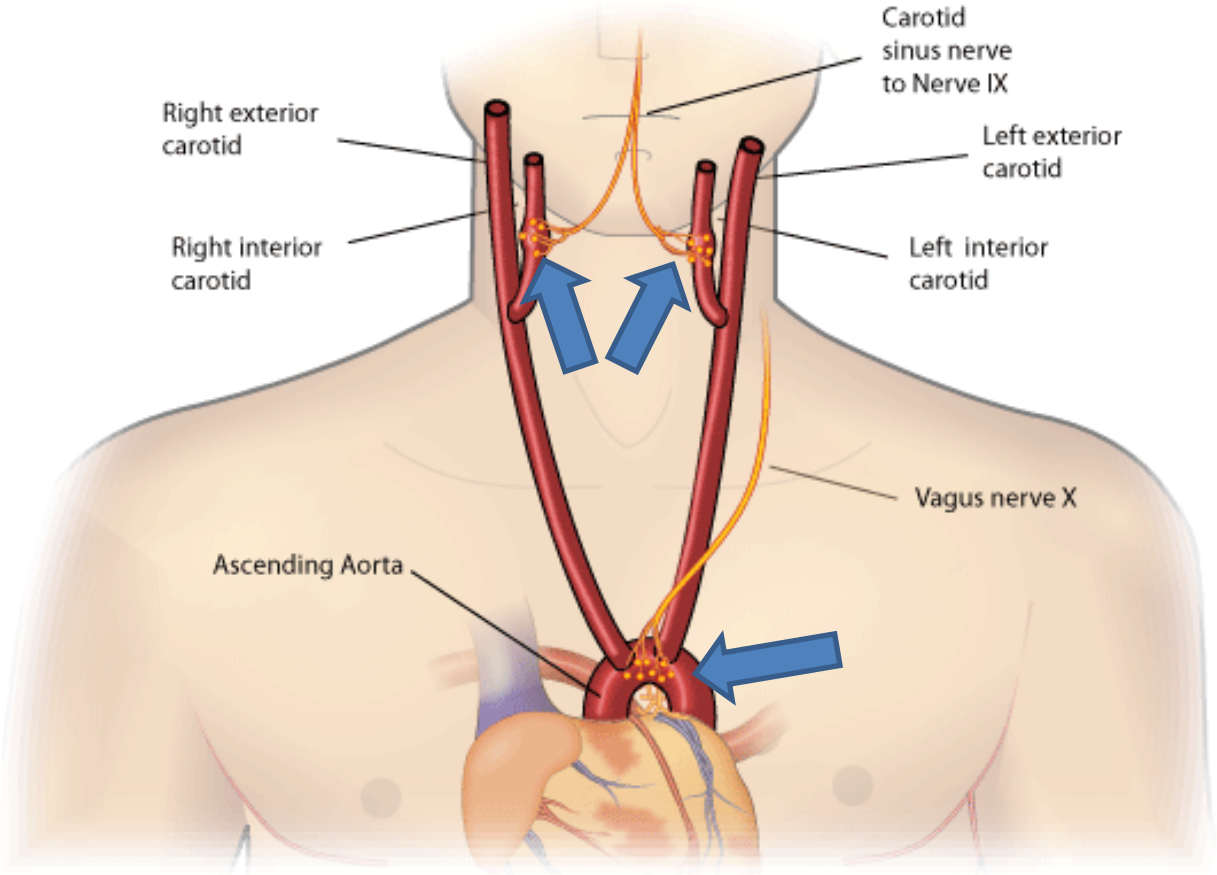
Controlul presiunii arteriale de catre SNS

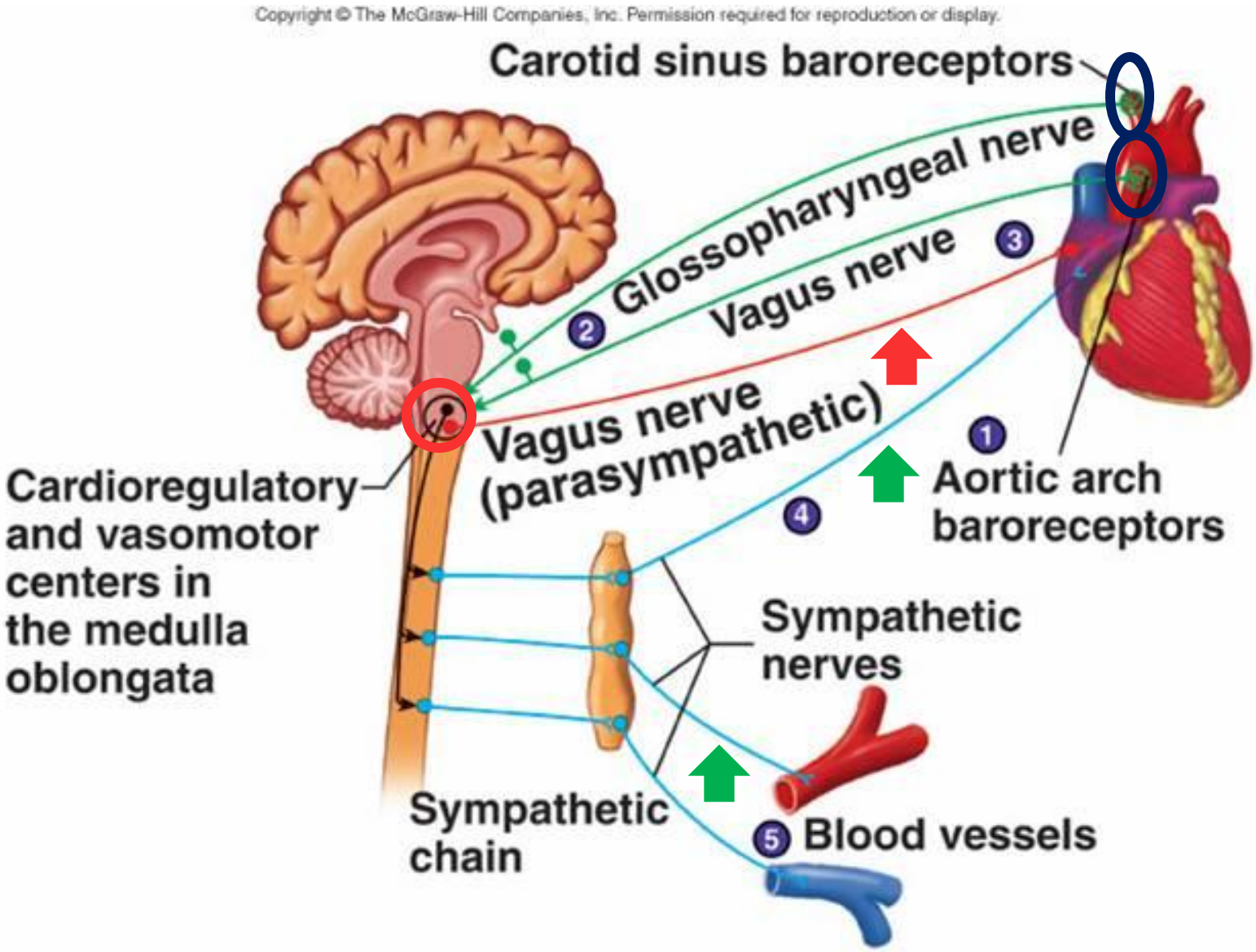


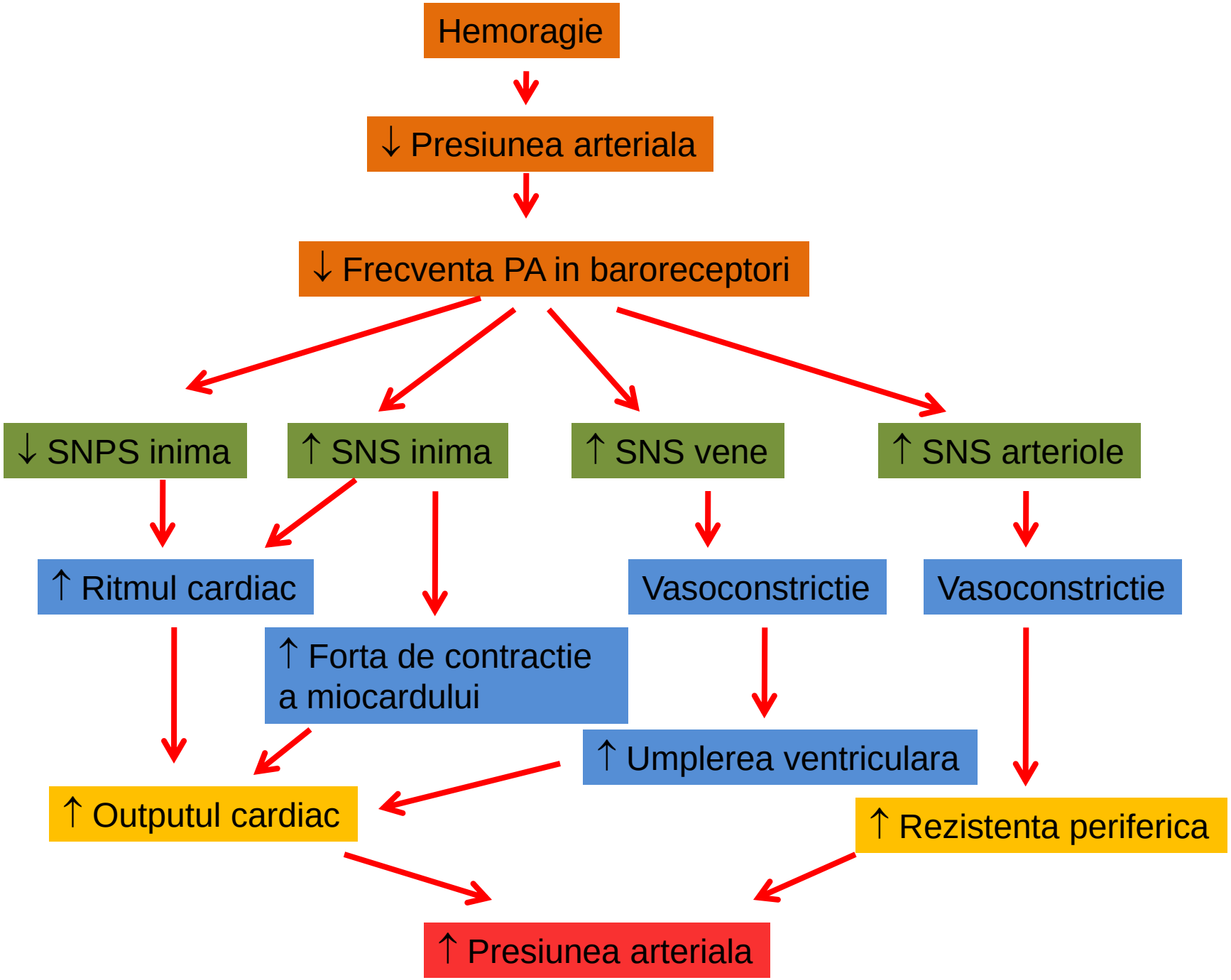
Baroreceptorii arteriali



-localizati in arcul aortic si in sinusurile carotidiene
-terminatii nervoase mecano-senzitive care detecteaza gradul de intindere al peretilor arteriali
- genereaza PA care se propaga catre SNC – centrul cardiovascular din bulb

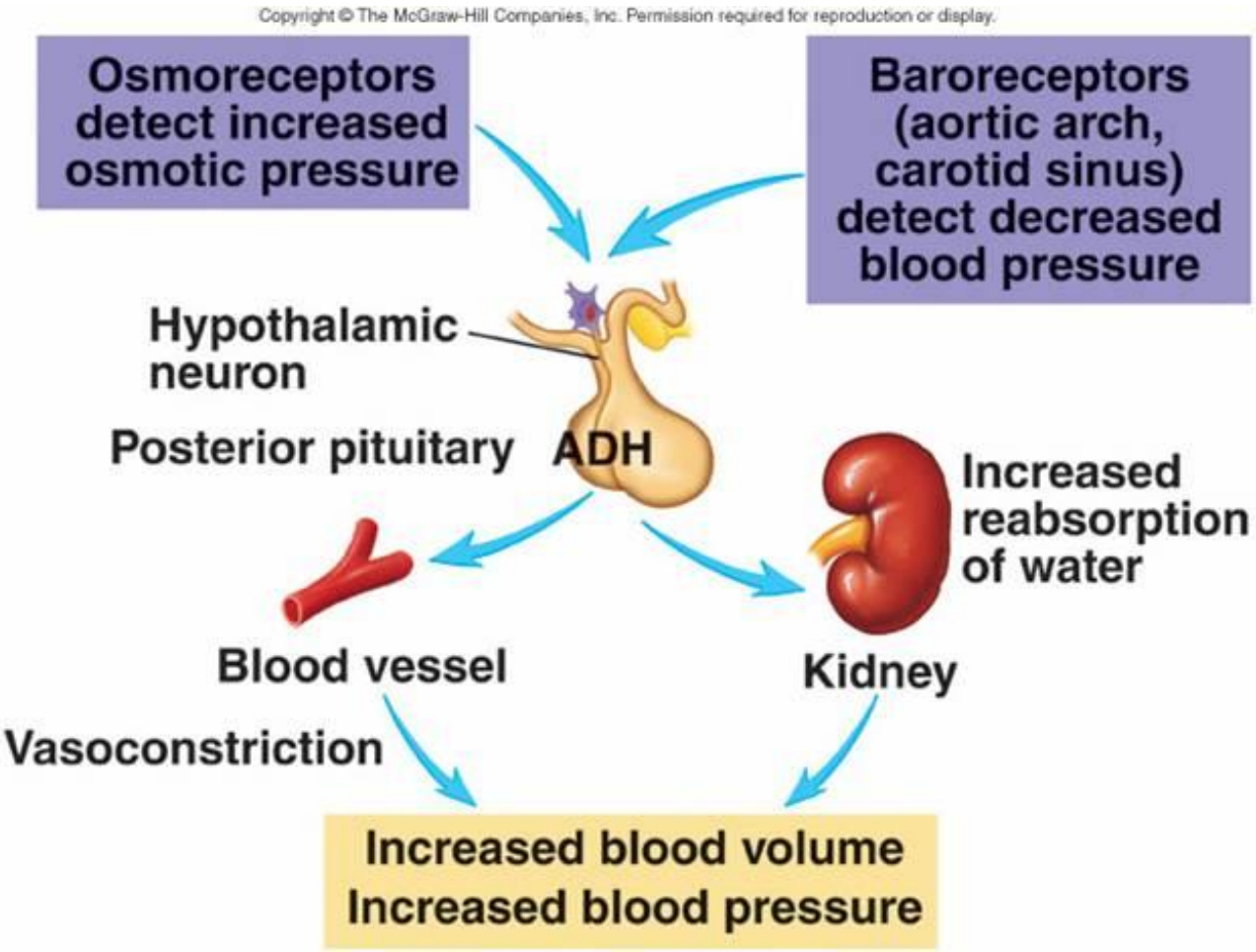
Reglarea presiunii arteriale




Hemoragie
↓ Presiunea arteriala
↓ Frecventa PA in baroreceptori
↓ SNPS inima
↑ SNS inima
↑ SNS vene
↑ SNS arteriole
↑ Ritmul cardiac
Vasoconstrictie
Vasoconstrictie
↑ Forta de contractie a miocardului
↑ Umplerea ventriculara
↑ Outputul cardiac
↑ Rezistenta periferica
↑ Presiunea arteriala

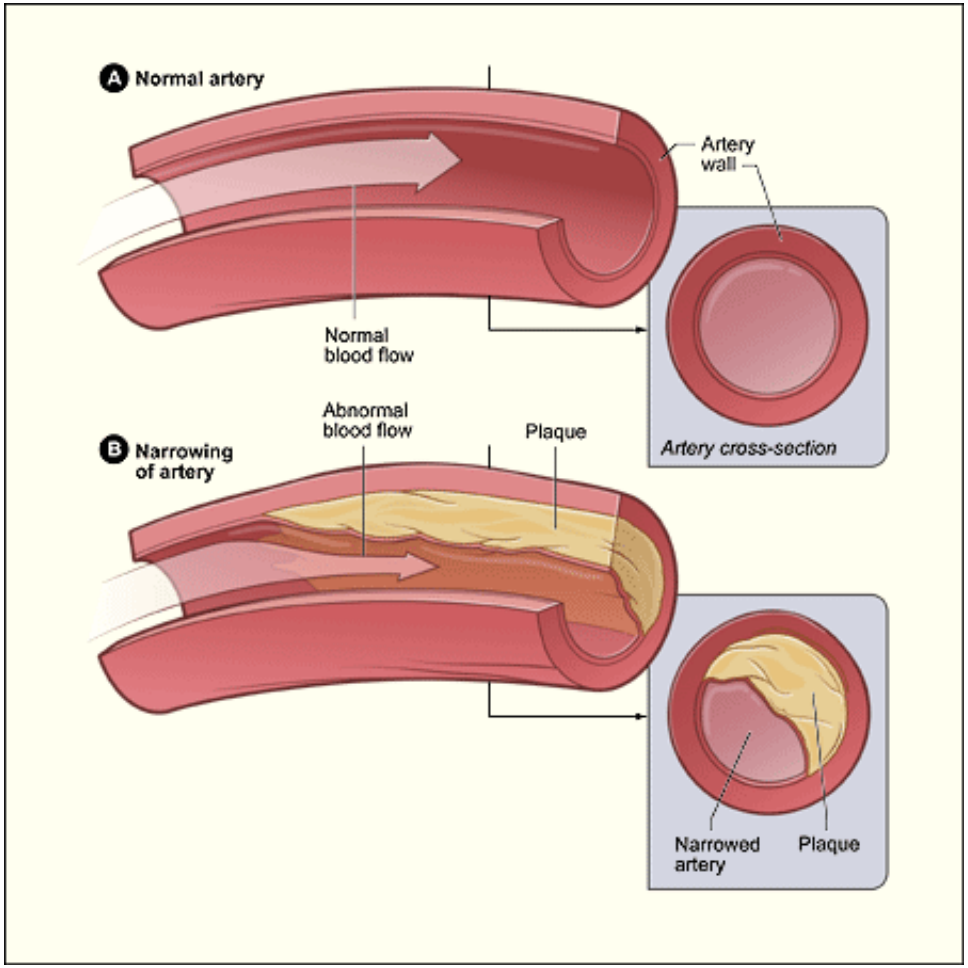
Controlul hormonal al presiunii arteriale

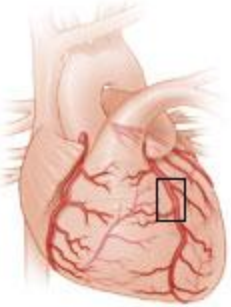
-”Fight or flight” – adrenalina – vasoconstrictie periferica (vasodilatare in muschi)
-Hemoragie, deshidratare – renina-angiotensina II - vasoconstrictie
-**Hemoragie, deshidratae – ADH – vasoconstrictie; retentie de apa**

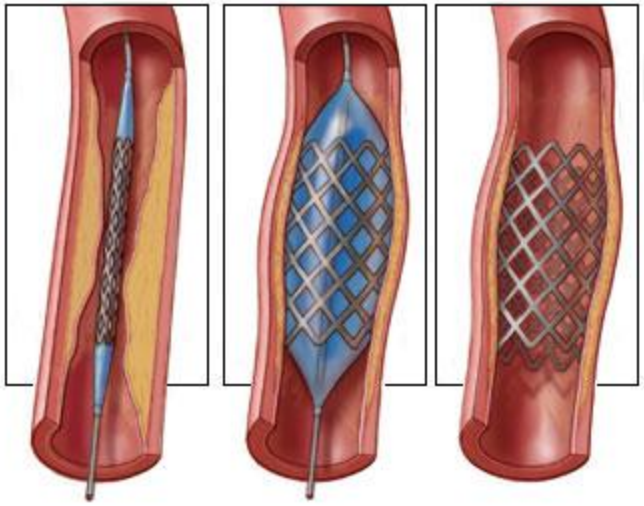


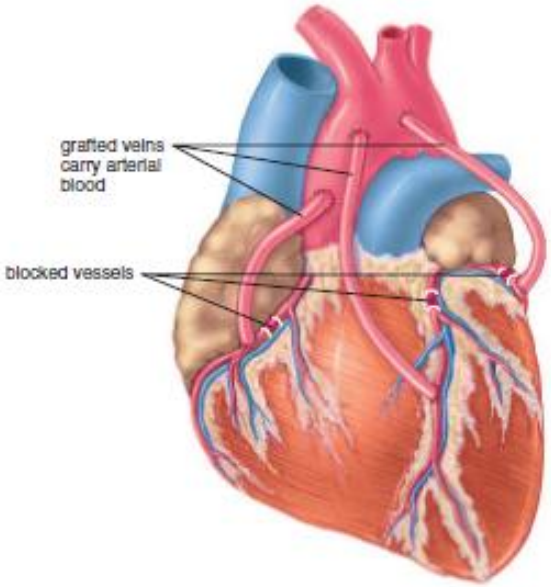
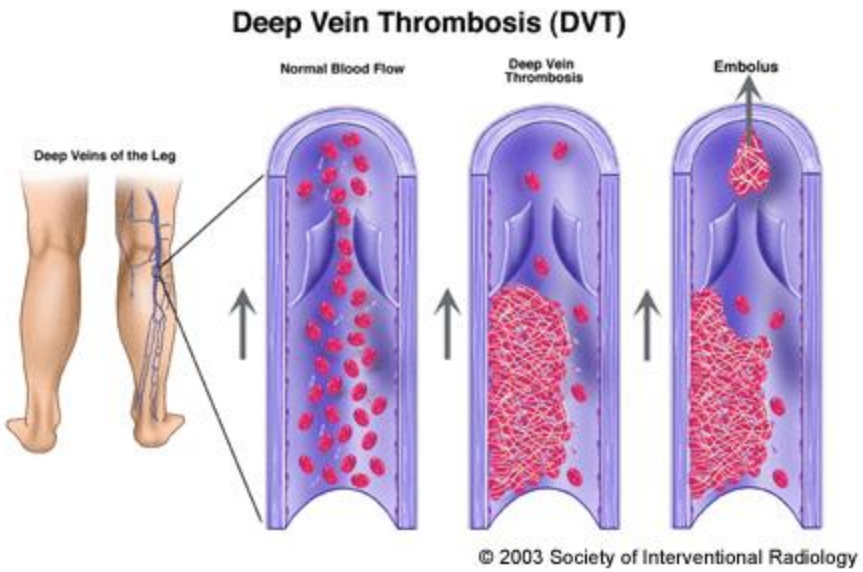
Ateroscleroza

-aterom vascular – leziune endoteliala – macrofage, limfocite – colesterol, lipide – muschi neted – tesut conjunctiv fibros (capsula) - trombus









Tromboza venoasa profunda