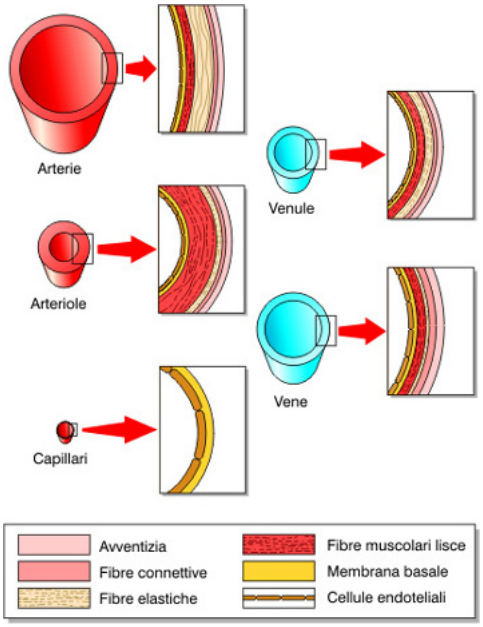

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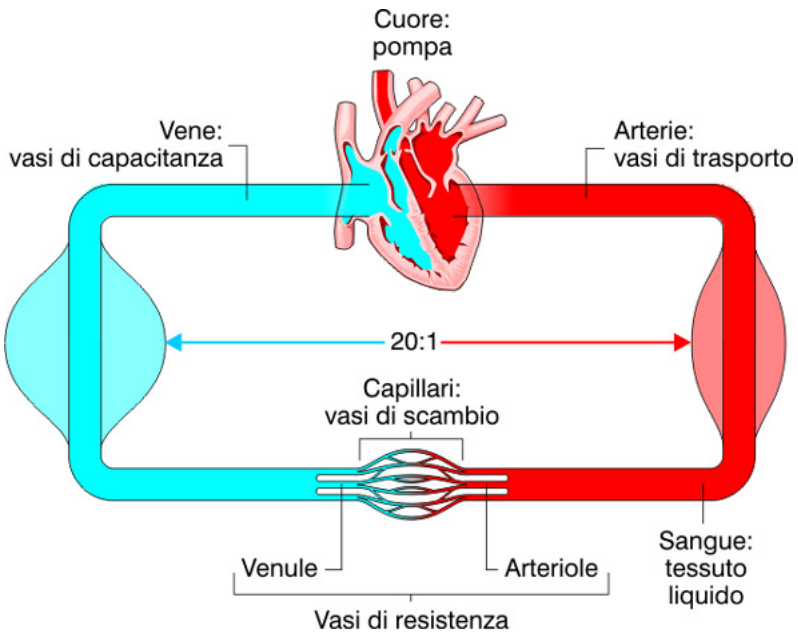

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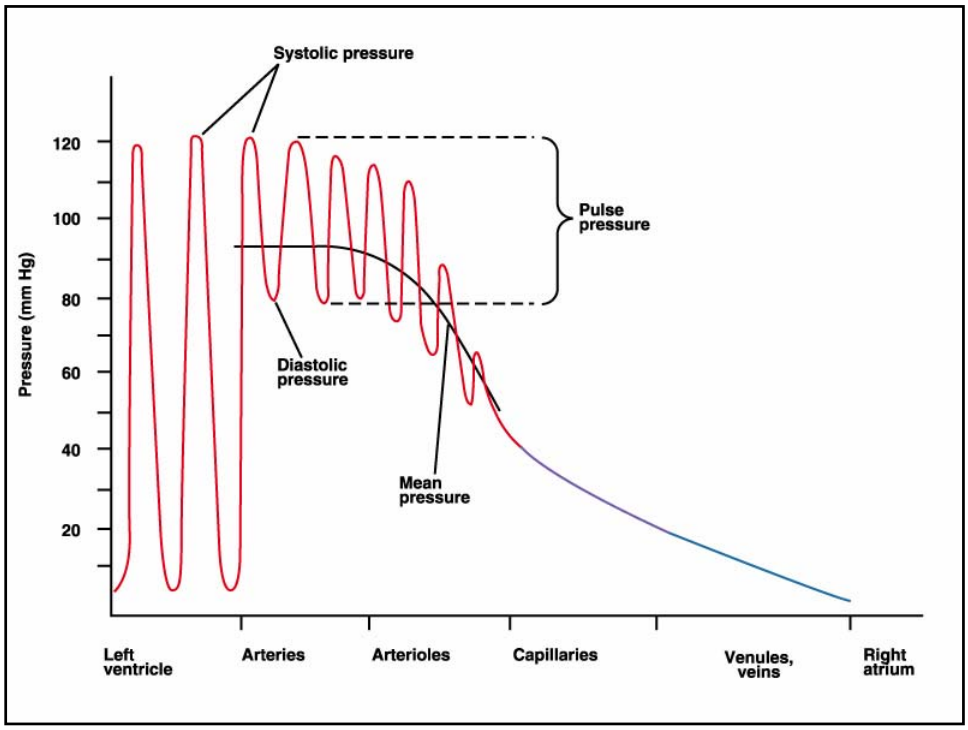
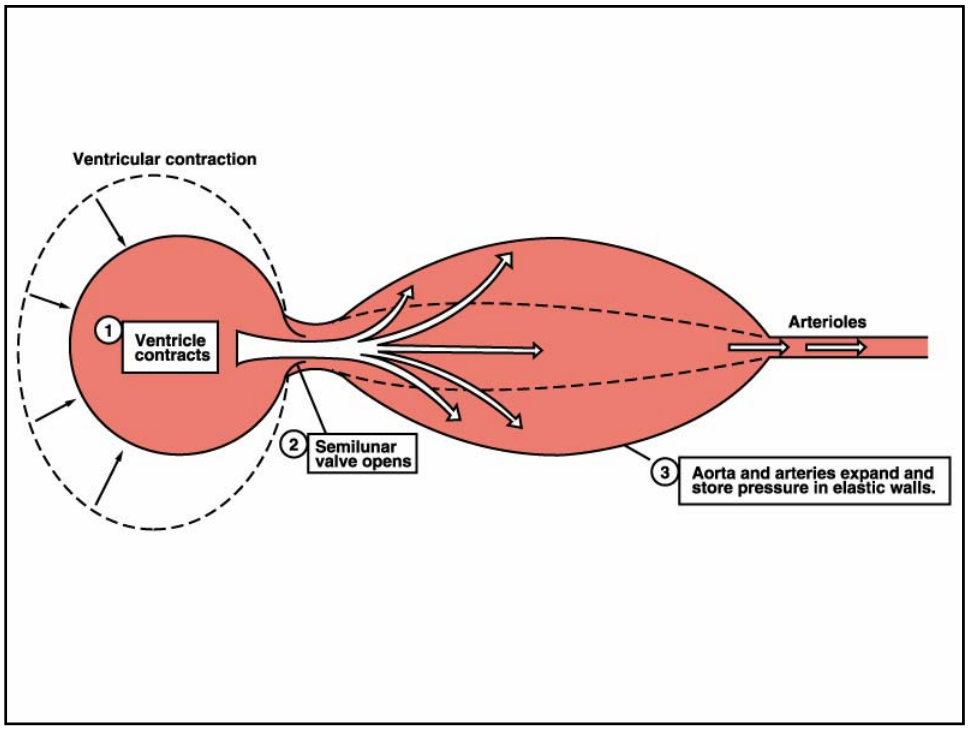
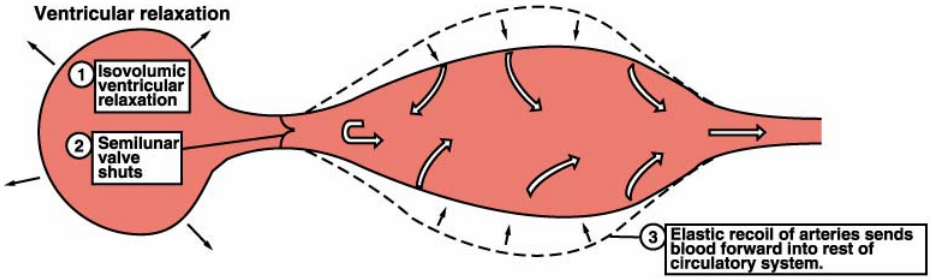
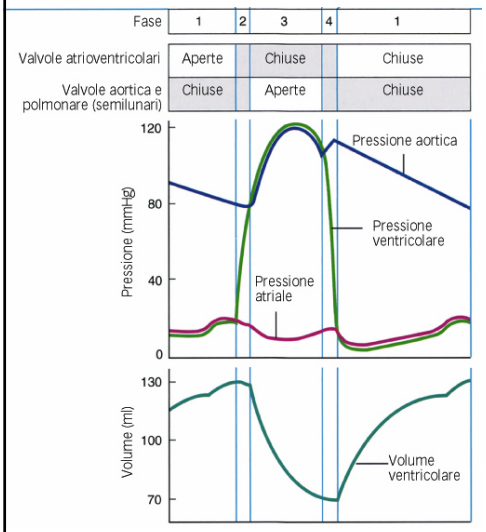
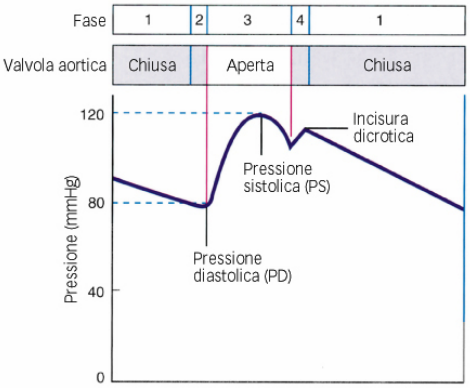

Systolic pressure
Pulse pressure
Diastolic pressure
Mean pressure
Pressure (mm Hg)
120
100
80
60
40
20
Left ventricle
Arteries
Arterioles
Capillaries
Venules, veins
Right atrium


Ventricular contraction
1 Ventricle contracts
2 Semilunar valve opens
3 Aorta and arteries expand and store pressure in elastic walls.
Arterioles

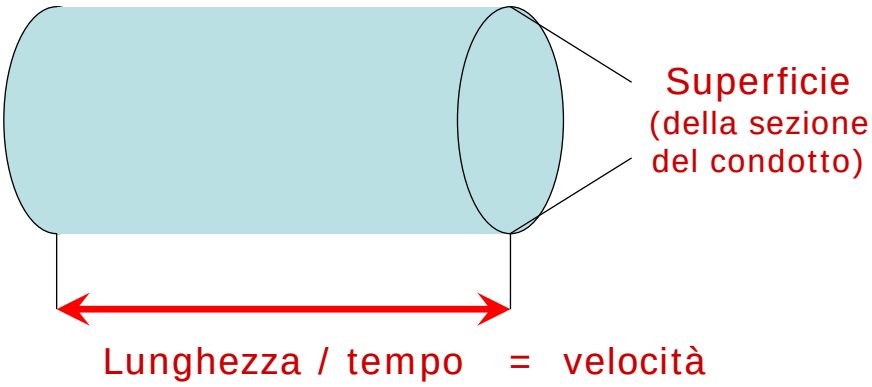

Ventricular relaxation
1 Isovolumic ventricular relaxation
2 Semilunar valve shuts
3 Elastic recoil of arteries sends blood forward into rest of circulatory system.


Fase
1
2
3
4
1
Valvole atrioventricolari
Aperte
Chiuse
Chiuse
Valvole aortica e polmonare (semilunari)
Chiuse
Aperte
Chiuse
Pressione (mmHg)
120
80
40
0
Pressione aortica
Pressione ventricolare
Pressione atriale
Volume (ml)
130
100
70
Volume ventricolare


Fase
1
2
3
4
1
Valvola aortica
Chiusa
Aperta
Chiusa
Pressione (mmHg)
120
80
40
0
Incisura dicrotica
Pressione sistolica (PS)
Pressione diastolica (PD)

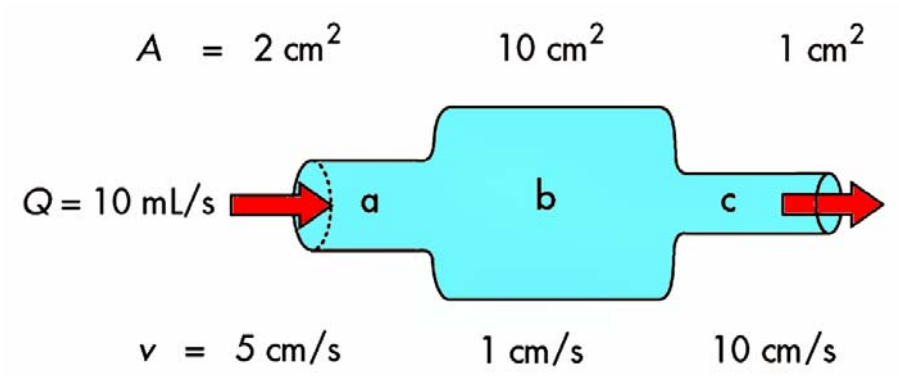
Fluidi in movimento

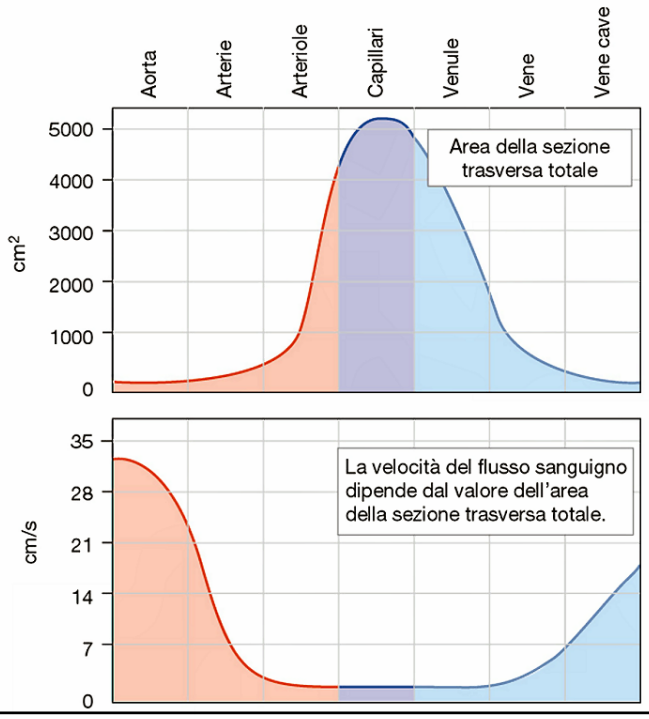
Flusso = Volume di fluido che passa nell'unità di tempo



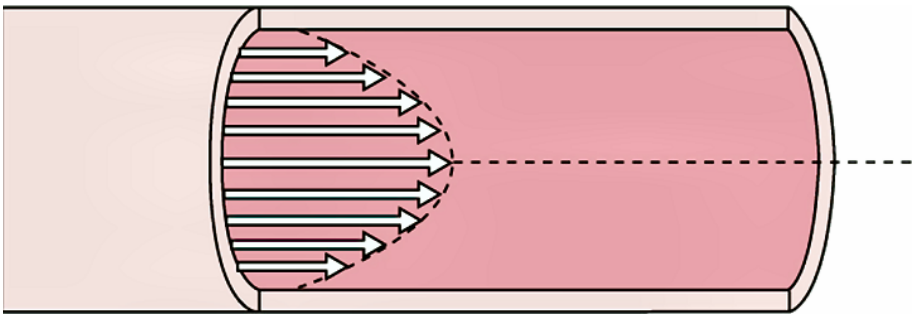
Flusso = velocità x superficie della sezione

La velocità è inversamente proporzionale alla superficie della sezione

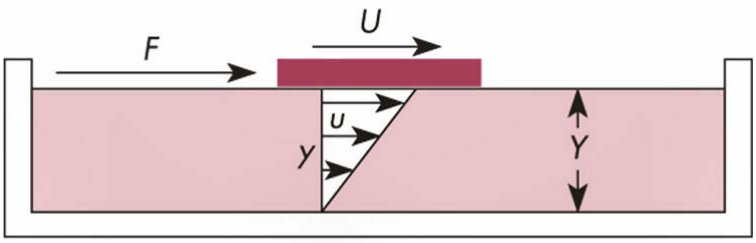




Il flusso laminare



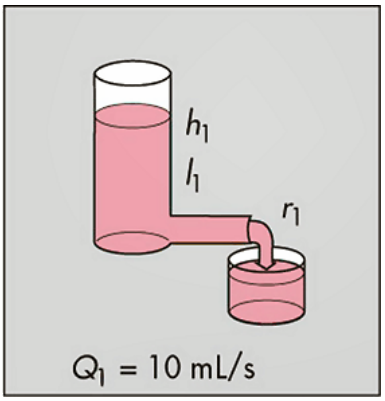
La viscosità (η)

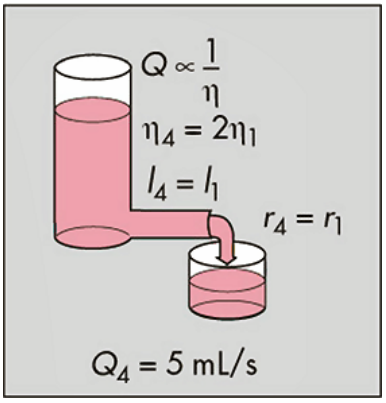


$$\eta = \frac{\tau}{du/dy} = \frac{F/A}{U/Y}$$

τ = tensione di taglio; du/dy = velocità di taglio;
F = forza applicata; *A* = area; *U* = velocità della lamina; *Y* = profondità del liquido.

Fattori che modificano il flusso





La legge di Poisseuille

$$Q = \frac{\pi \, \Delta P \, r^4}{8 \, \eta \, l}$$

Il flusso quindi è:

- Direttamente proporzionale alla pressione (ΔP);
- Direttamente proporzionale alla quarta potenza del raggio;
- Inversamente proporzionale alla lunghezza;
- Inversamente proporzionale alla viscosità.

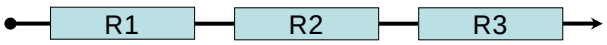
La legge di Ohm

$$R = \frac{\Delta V}{I} \qquad R = \frac{\Delta P}{Q}$$

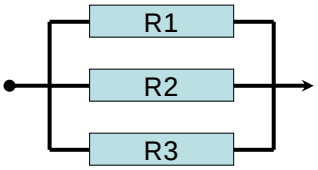
$$Q = \frac{\pi \Delta P r^4}{8 \eta l}$$

$$R = \cancel{\Delta P} \frac{8 \eta l}{\pi \cancel{\Delta P} r^4} \qquad R = \frac{8 \eta l}{\pi r^4}$$

Resistenze in serie o in parallelo

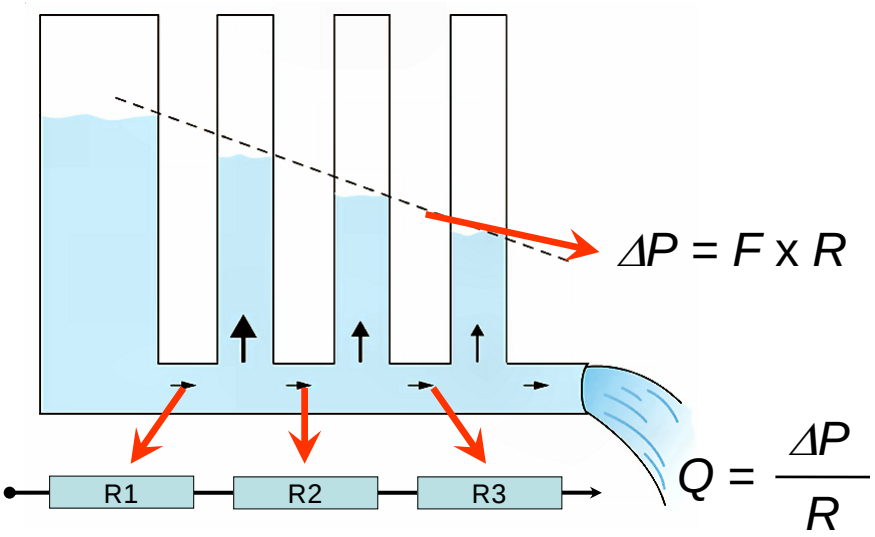


R = R1 + R2 + R3



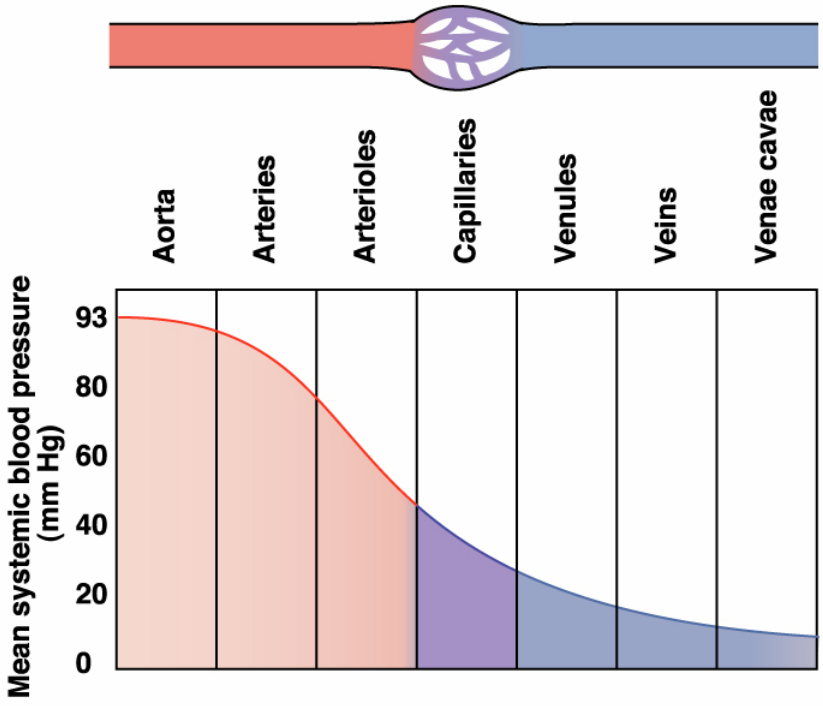
1/R = 1/R1 + 1/R2 + 1/R3

Resistenze in serie

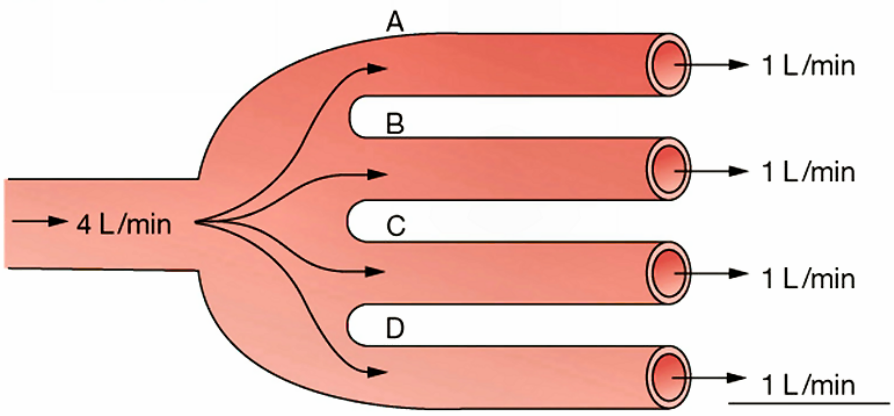


$$\Delta P = F \times R$$

$$Q = \frac{\Delta P}{R}$$

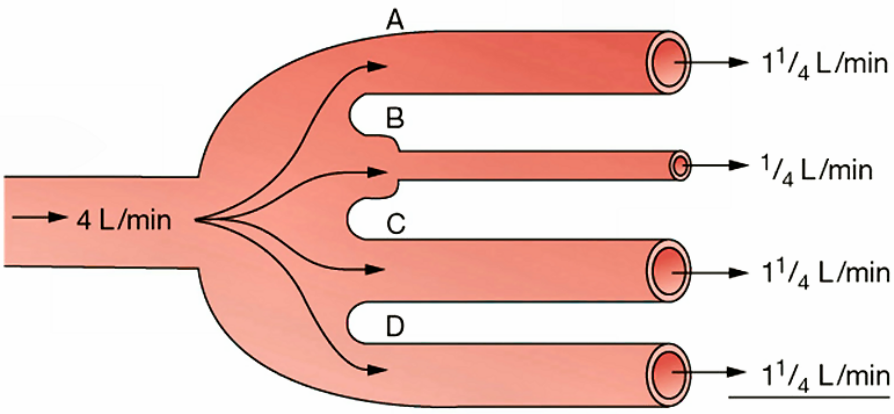


Resistenze in parallelo

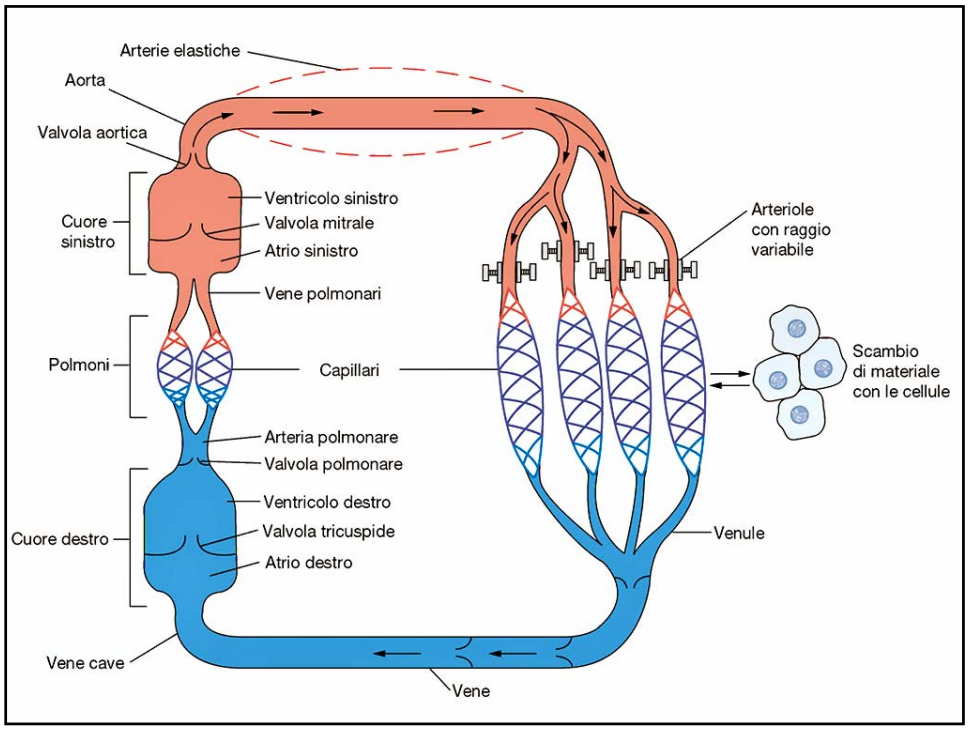


Flusso totale: 4 L/min

Resistenze in parallelo



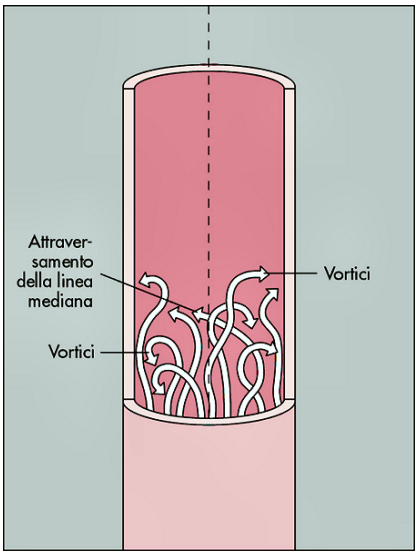
Flusso totale immodificato: 4 L/min

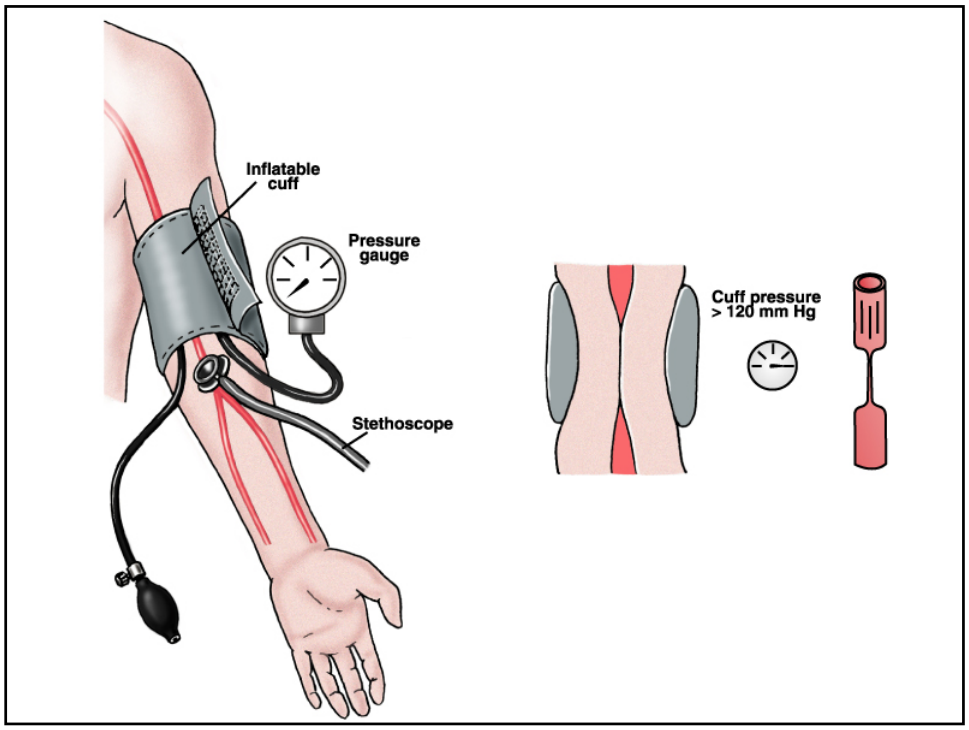


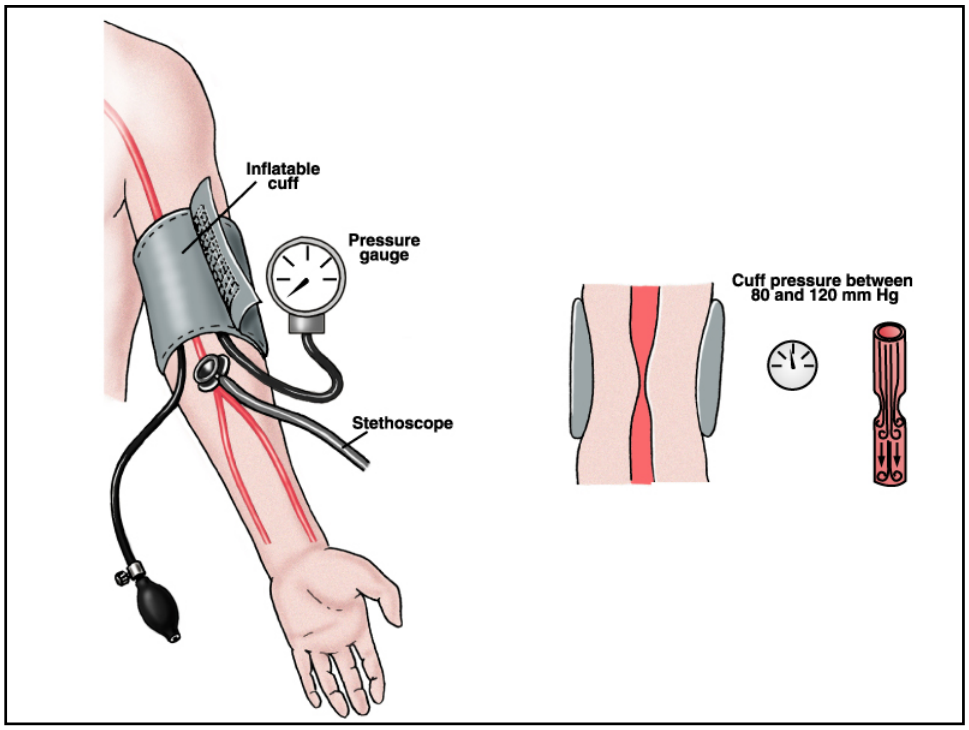
Il numero di Reynolds

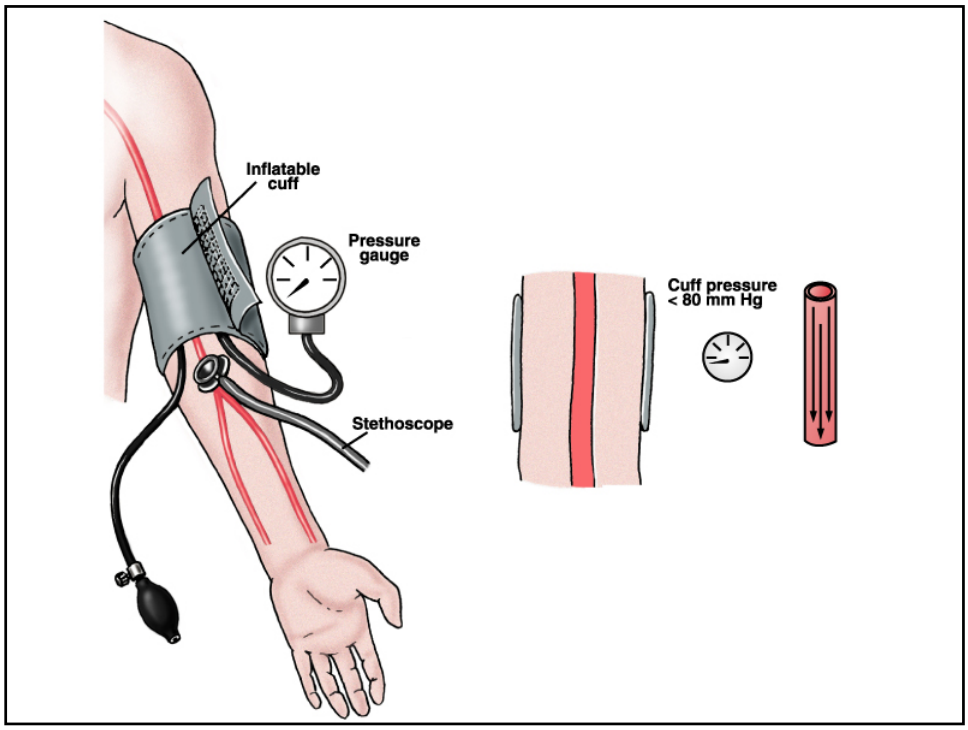
$$N = \frac{r\,\bar{v}\,\delta}{\eta}$$

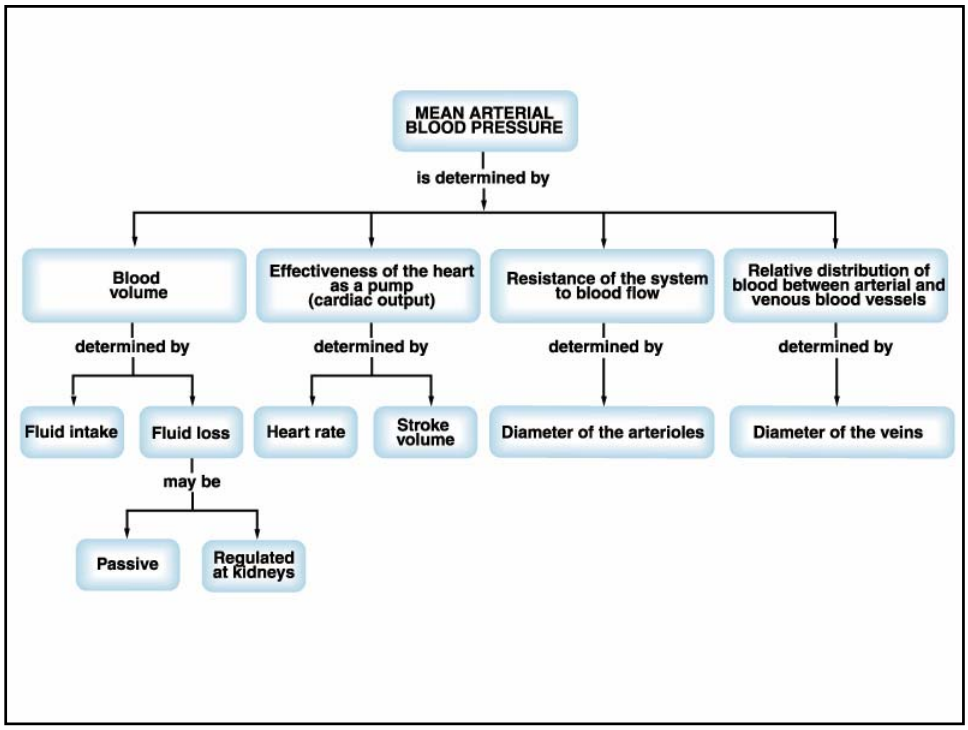
se N > 2000
flusso turbolento

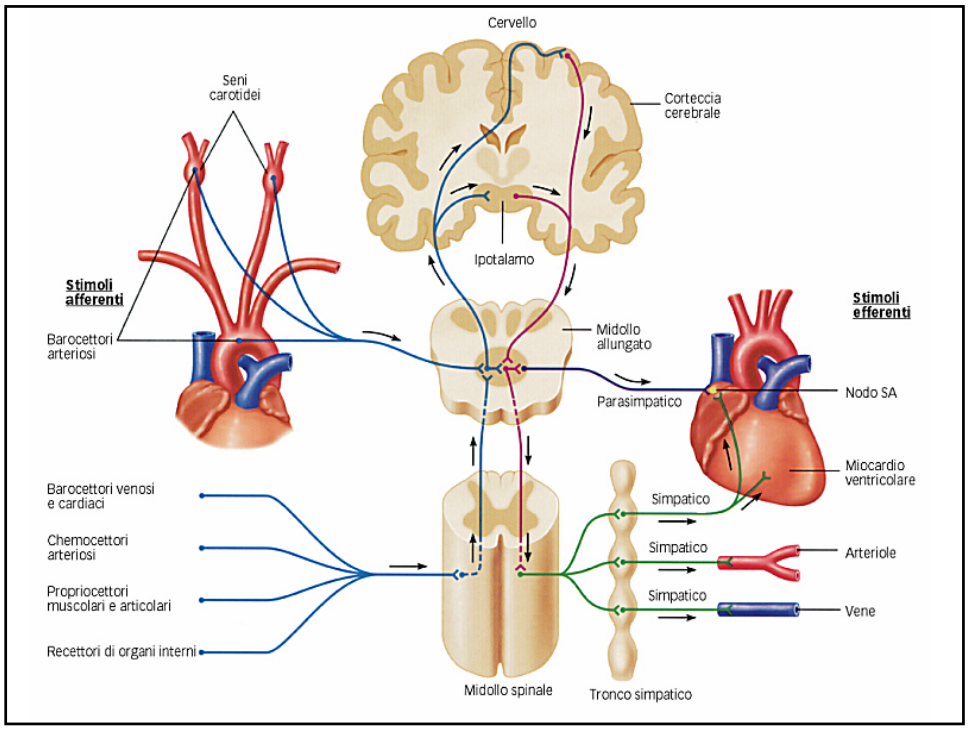


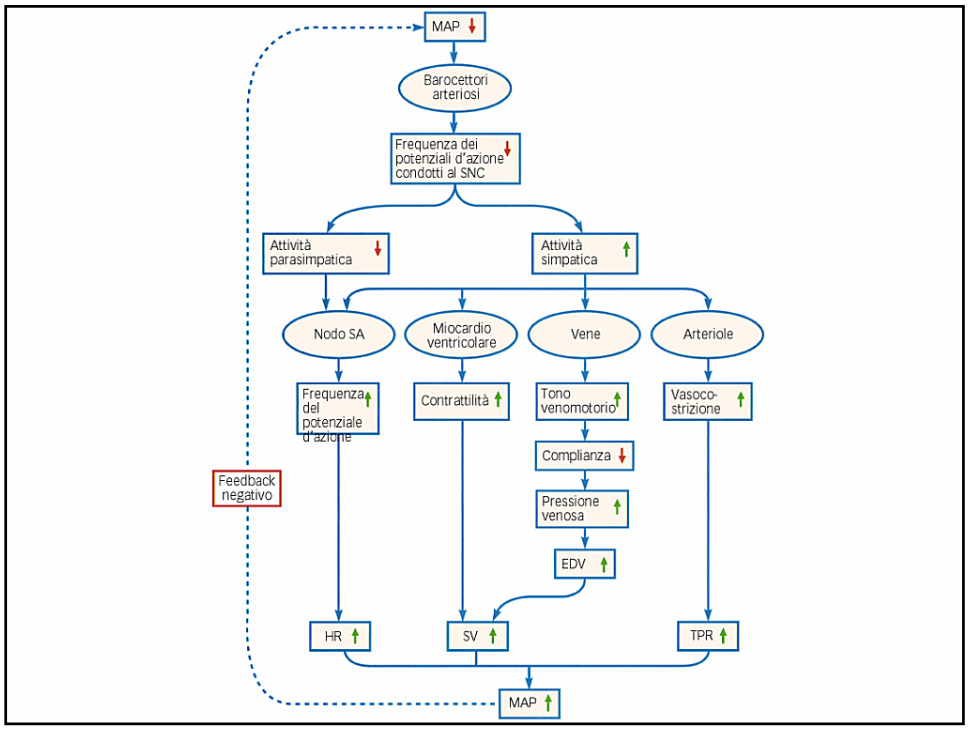

Inflatable cuff
Pressure gauge
Stethoscope
Cuff pressure > 120 mm Hg

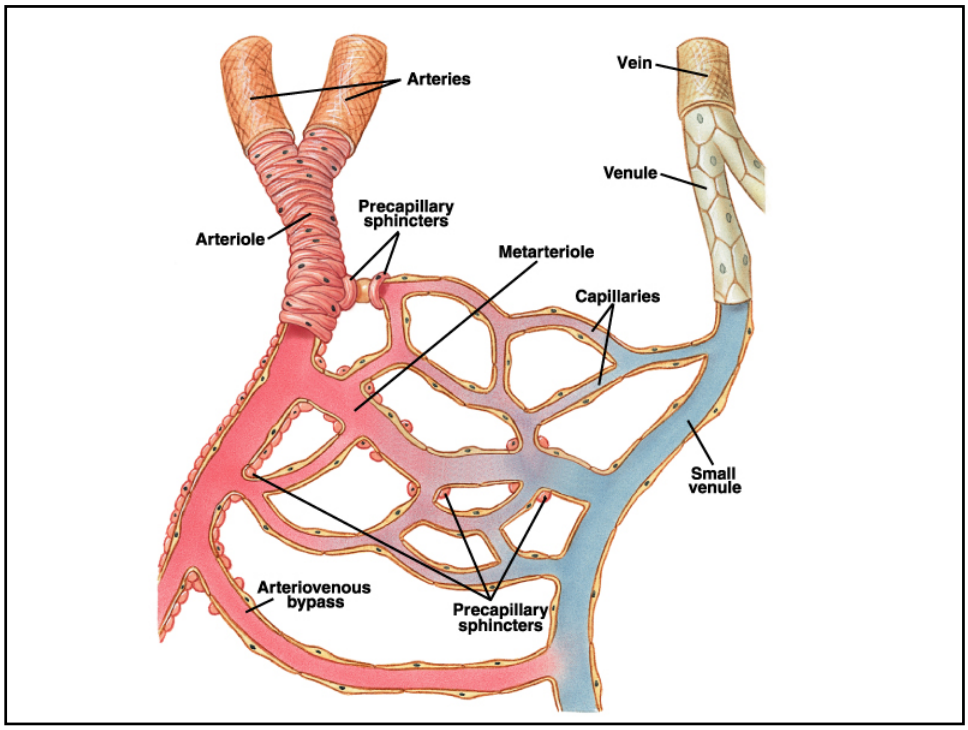

Inflatable cuff
Pressure gauge
Stethoscope
Cuff pressure between 80 and 120 mm Hg

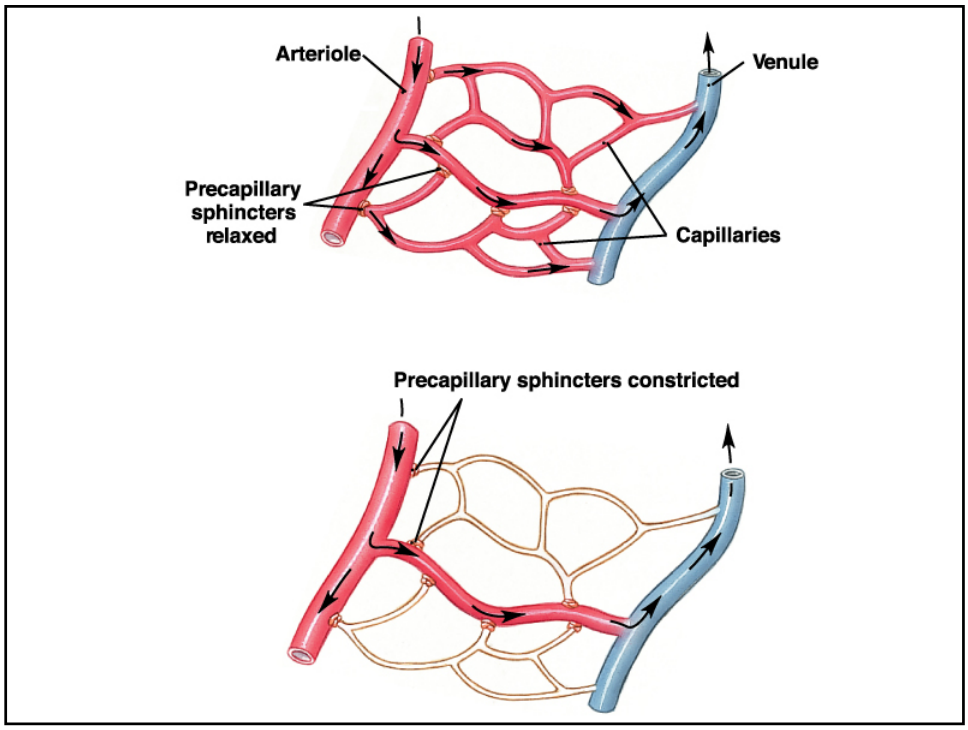

Inflatable cuff
Pressure gauge
Stethoscope
Cuff pressure < 80 mm Hg

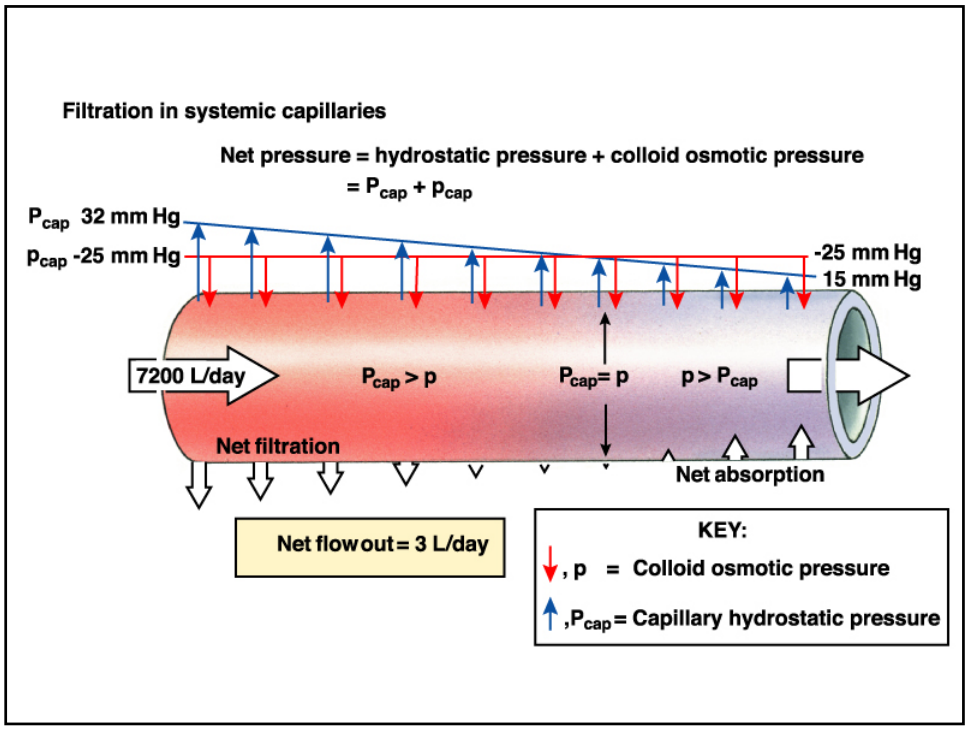

MEAN ARTERIAL BLOOD PRESSURE
is determined by
Blood volume
Effectiveness of the heart as a pump (cardiac output)
Resistance of the system to blood flow
Relative distribution of blood between arterial and venous blood vessels
determined by
determined by
determined by
determined by
Fluid intake
Fluid loss
Heart rate
Stroke volume
Diameter of the arterioles
Diameter of the veins
may be
Passive
Regulated at kidneys

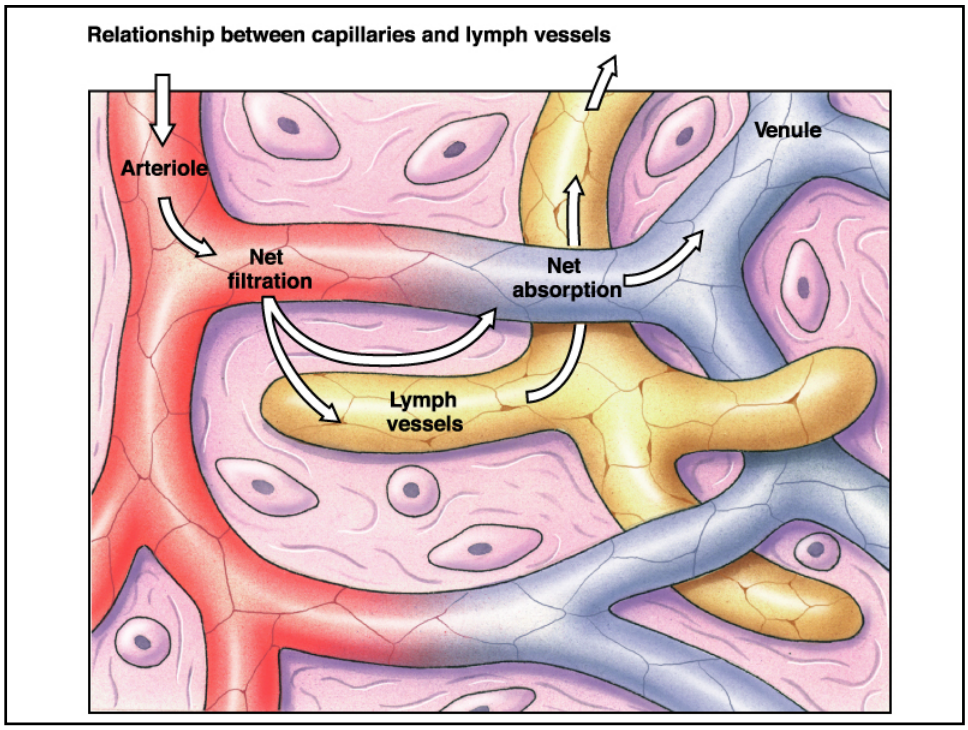

Cervello
Seni carotidei
Corteccia cerebrale
Ipotalamo
Stimoli afferenti
Barocettori arteriosi
Midollo allungato
Stimoli efferenti
Parasimpatico
Nodo SA
Miocardio ventricolare
Barocettori venosi e cardiaci
Chemocettori arteriosi
Propriocettori muscolari e articolari
Recettori di organi interni
Simpatico
Simpatico
Simpatico
Arteriole
Vene
Midollo spinale
Tronco simpatico

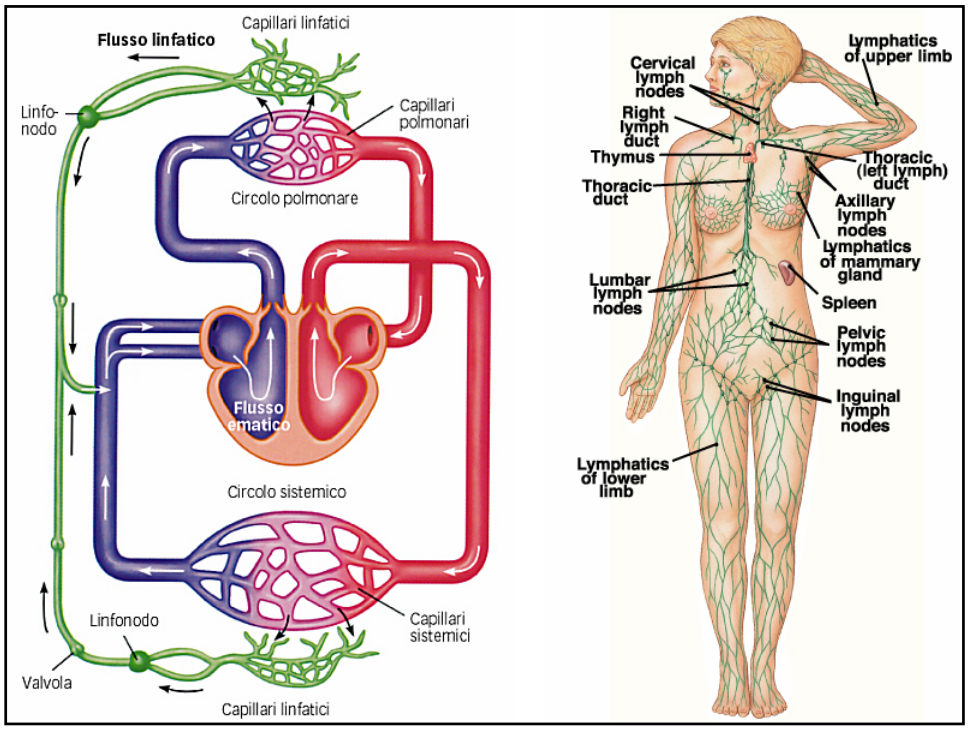

MAP ↓
Barocettori arteriosi
Frequenza dei potenziali d'azione condotti al SNC ↓
Attività parasimpatica ↓
Attività simpatica ↑
Nodo SA
Miocardio ventricolare
Vene
Arteriole
Frequenza del potenziale d'azione ↑
Contrattilità ↑
Tono venomotorio ↑
Vasocostrizione ↑
Complianza ↓
Pressione venosa ↑
EDV ↑
Feedback negativo
HR ↑
SV ↑
TPR ↑
MAP ↑

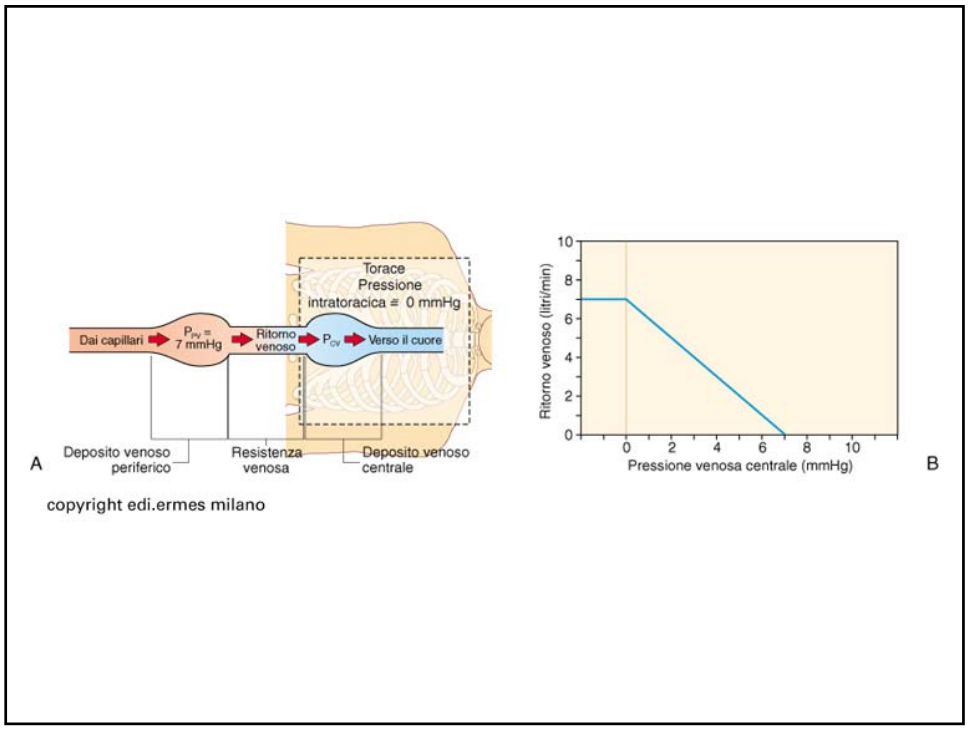

Arteries
Vein
Venule
Precapillary sphincters
Arteriole
Metarteriole
Capillaries
Small venule
Arteriovenous bypass
Precapillary sphincters


Arteriole
Venule
Precapillary sphincters relaxed
Capillaries
Precapillary sphincters constricted


Filtration in systemic capillaries
Net pressure = hydrostatic pressure + colloid osmotic pressure
= Pcap + pcap
Pcap 32 mm Hg
pcap -25 mm Hg
-25 mm Hg
15 mm Hg
7200 L/day
Pcap > p
Pcap= p
p > Pcap
Net filtration
Net absorption
Net flow out = 3 L/day
KEY:
, p = Colloid osmotic pressure
,Pcap = Capillary hydrostatic pressure


Relationship between capillaries and lymph vessels
Arteriole
Venule
Net filtration
Net absorption
Lymph vessels


Capillari linfatici
Flusso linfatico
Linfo-
nodo
Capillari
polmonari
Circolo polmonare
Flusso
ematico
Circolo sistemico
Linfonodo
Capillari
sistemici
Valvola
Capillari linfatici
Lymphatics
of upper limb
Cervical
lymph
nodes
Right
lymph
duct
Thymus
Thoracic
duct
Thoracic
(left lymph)
duct
Axillary
lymph
nodes
Lymphatics
of mammary
gland
Lumbar
lymph
nodes
Spleen
Pelvic
lymph
nodes
Inguinal
lymph
nodes
Lymphatics
of lower
limb


Torace
Pressione
intratoracica ≅ 0 mmHg
Dai capillari
P_{PV} =
7 mmHg
Ritorno
venoso
P_{CV}
Verso il cuore
Deposito venoso
periferico
Resistenza
venosa
Deposito venoso
centrale
A
Ritorno venoso (litri/min)
10
8
6
4
2
0
0
2
4
6
8
10
Pressione venosa centrale (mmHg)
B
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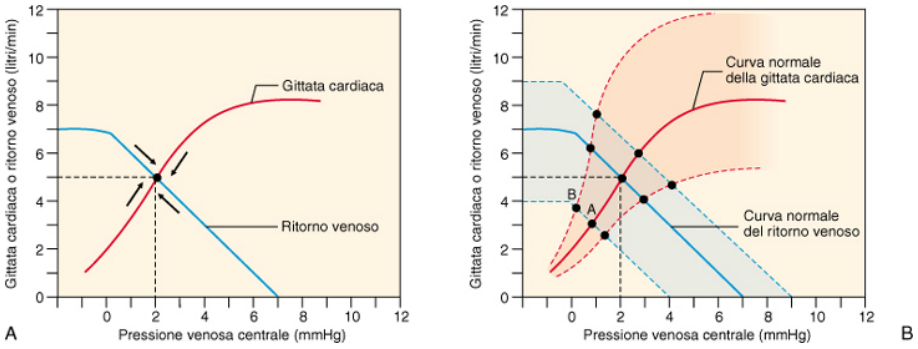
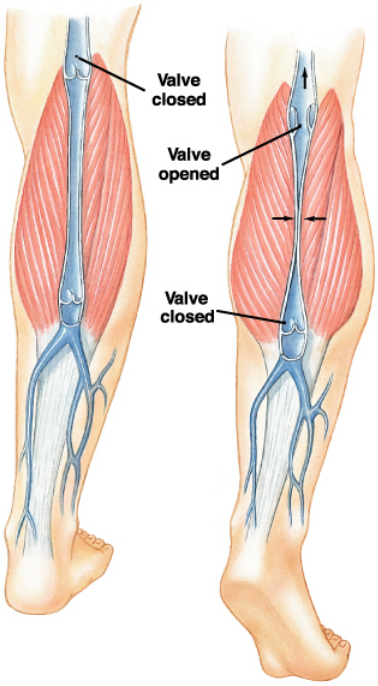
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