MECCANICA dei FLUIDI nei SISTEMI BIOLOGICI

parte Ia

- EQUAZIONE DI CONTINUITA'

Lucidi del Prof. D. Scannicchio

MASSA, PESO, DENSITA'

- m $\qquad kg_{massa} \qquad g_{massa}$

- $\vec{p} = m\,\vec{g}$ $\qquad kg_{peso} \qquad g_{peso}$

$$kg_{peso} = kg_{massa}\ 9.8\ m\ s^{-2} = 9.8\ N$$

- $d = \dfrac{m}{V}$ $\qquad [d] = [M]\,[L]^{-3}$

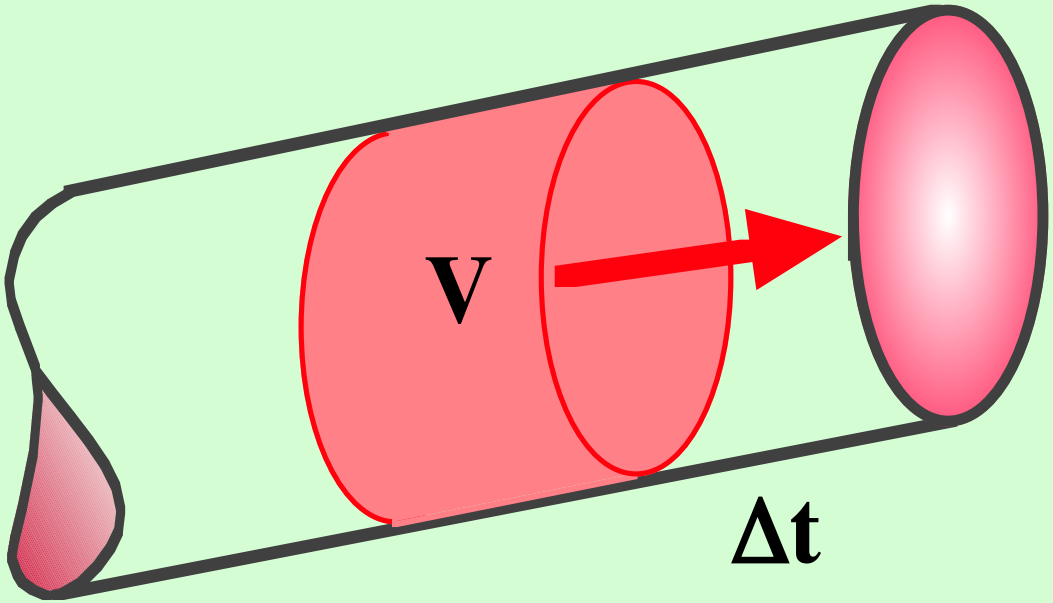
  - **S.I.** $kg\ m^{-3}$ $\qquad$ **C.G.S.** $g\ cm^{-3}$

$$H_2O \rightarrow d = 1\ g\ cm^{-3} = 1000\ kg\ m^{-3}$$

a 4°C e 1 bar

PORTATA di un FLUIDO

o FLUSSO
di velocità

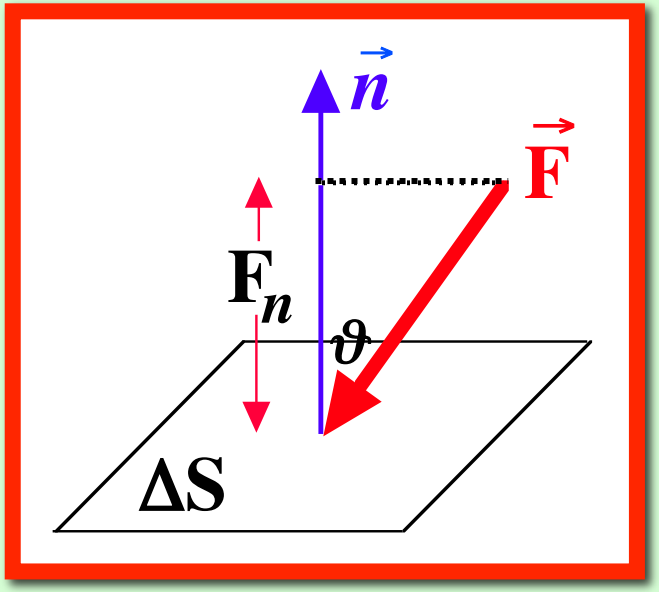


$$Q = \frac{V}{\Delta t}$$

$$[Q] = [L]^3\,[t]^{-1}$$

- **S.I.** $m^3\,s^{-1}$ **C.G.S.** $cm^3\,s^{-1}$

PRESSIONE



- $$p = \frac{|\vec{F}_n|}{\Delta S} = \frac{\vec{F} \cdot \vec{n}}{\Delta S}$$

$$[p] = \frac{[M][L][t]^{-2}}{[L]^2} = [M][L]^{-1}[t]^{-2}$$

- **S.I.** → N/m^2 ≡ pascal (Pa)

C.G.S. → $dina/cm^2$ ≡ baria

$$pascal = \frac{10^5 \text{ dine}}{10^4 \text{ cm}^2} = 10 \text{ barie}$$

1 bar=10^6 barie=10^5 Pa

PRESSIONE

(0°C)

1 atmosfera = 760 mmHg ≡ 760 tor = $1.012\ 10^6$ barie =

= $1.012\ 10^5$ Pa = 1033 g_{peso} cm^{-2}

legge di Stevino

pressione idrostatica $p = d\ g\ h$ =

= $13.59\ g\ cm^{-2}\ 980\ cm\ s^{-2}\ 76\ cm = 1.012\ 10^6$ barie

densita' Hg

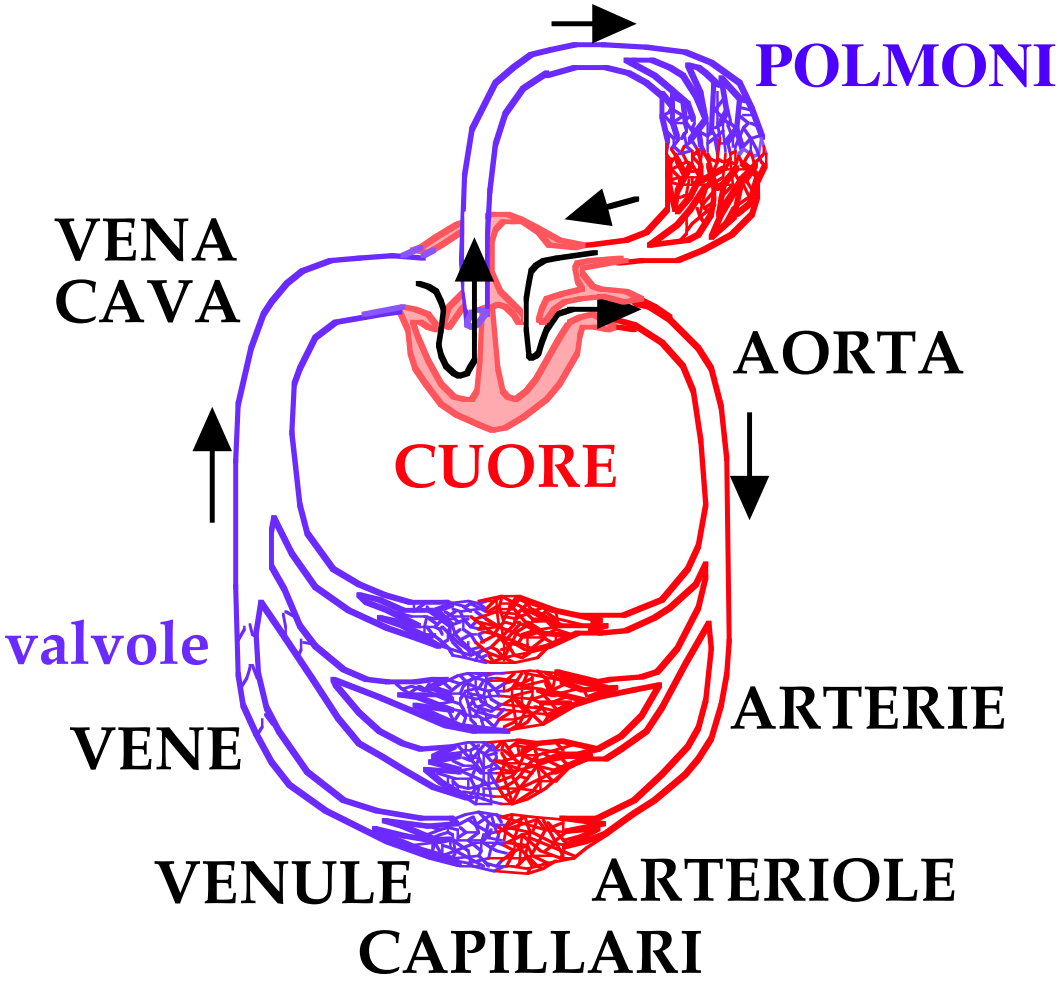
1 bar=10^6 barie=10^5 Pa

1 baria = 7.510×10^{-4} mmHg

1 mmHg = 1332 barie

SISTEMA CIRCOLATORIO

$V_{tot} \sim 6\ l$ $Q \sim 5\ l/min$



- pressione media (nel tempo)
- velocità media (nel tempo)

AORTA
ARTERIE
ARTERIOLE
CAPILLARI
VENULE
VENE
VENA CAVA

SISTEMA CIRCOLATORIO

- pressione media (nel tempo)
- velocità media (nel tempo)

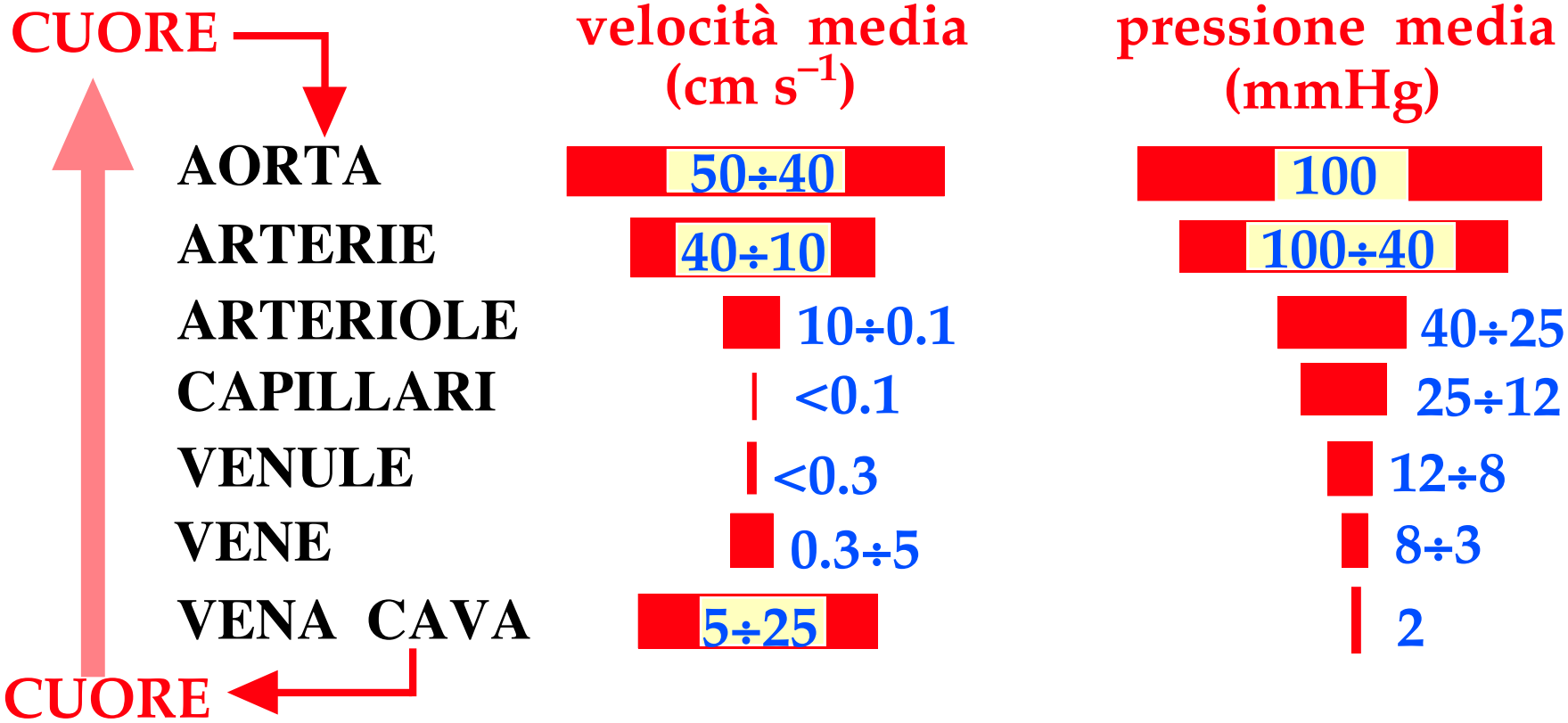


immagine da microscopia elettronica

arteriole e capillari

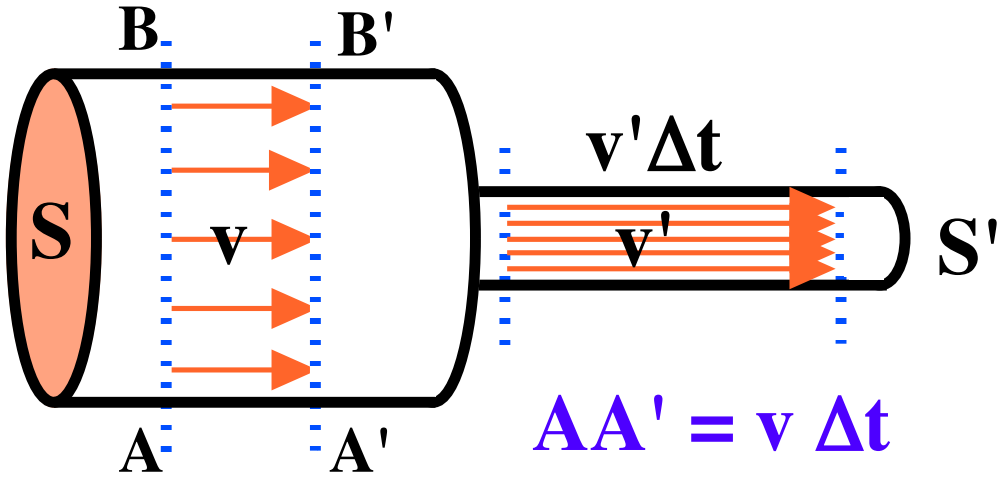
100 μμ

EQUAZIONE di CONTINUITA'

(Legge di Leonardo o della conservazione della massa)

- **LINEE di VELOCITA'**
- **MOTO STAZIONARIO :**

Q = costante nel tempo in ogni sezione



$$Q = \frac{V}{\Delta t} = \frac{S\, v\, \cancel{\Delta t}}{\cancel{\Delta t}} = S\, v = \text{costante}$$

EQUAZIONE di CONTINUITA'

$$Q = \frac{V}{\Delta t} = \frac{S\, v\, \cancel{\Delta t}}{\cancel{\Delta t}} = S\, v = \text{costante}$$

$$S\, v = S'\, v' \longrightarrow v' = \frac{S\, v}{S'}$$

- **EQUAZIONE di CONTINUITA'**

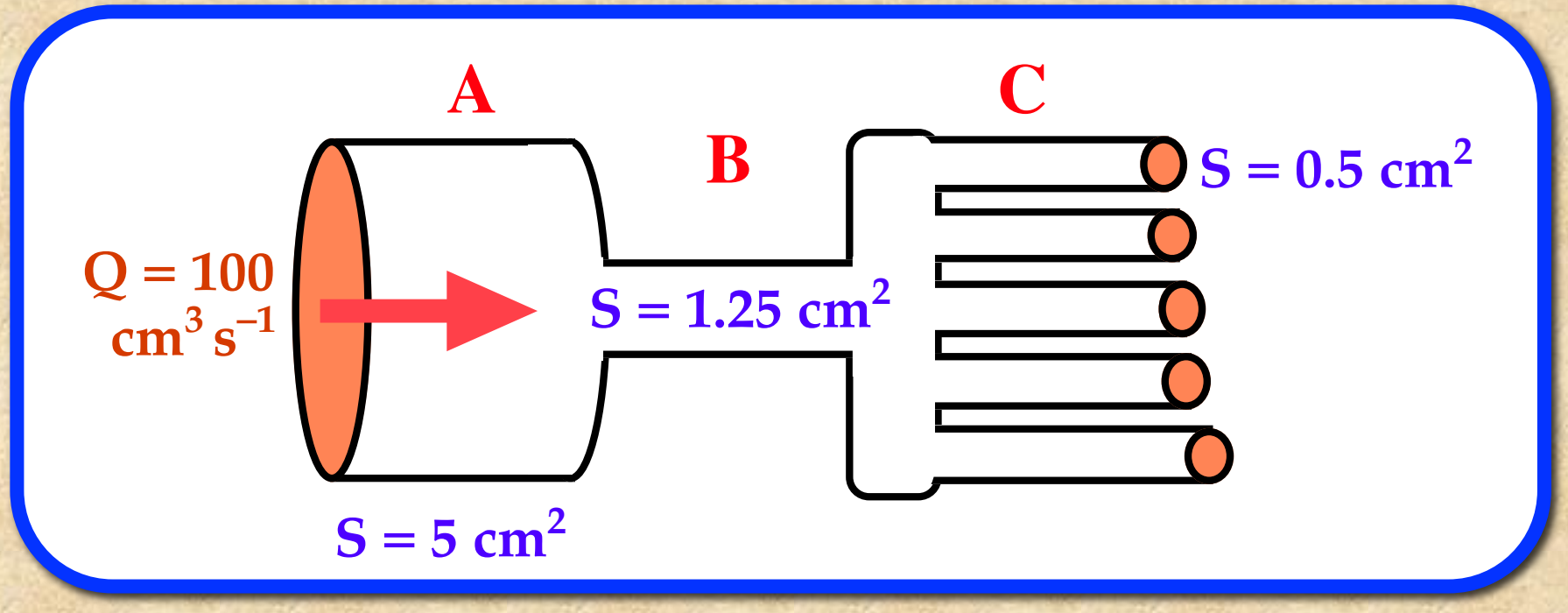
S v = costante $\longrightarrow$ $S_1 v_1 = S_2 v_2$

(ASSENZA di SORGENTI o di BUCHI)

EQUAZIONE di CONTINUITA'

$$S_1 v_1 = S_2 v_2$$

esempio

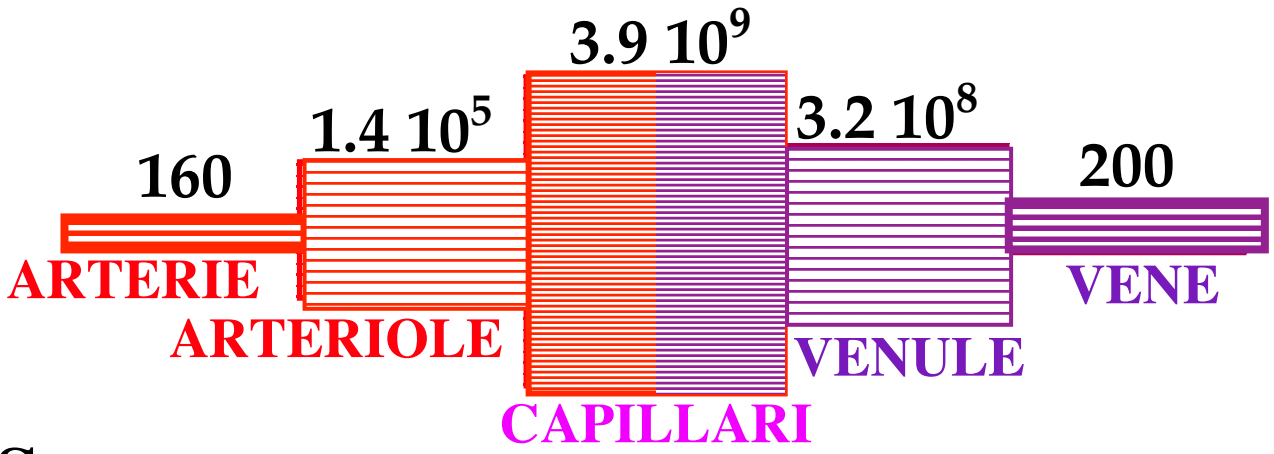


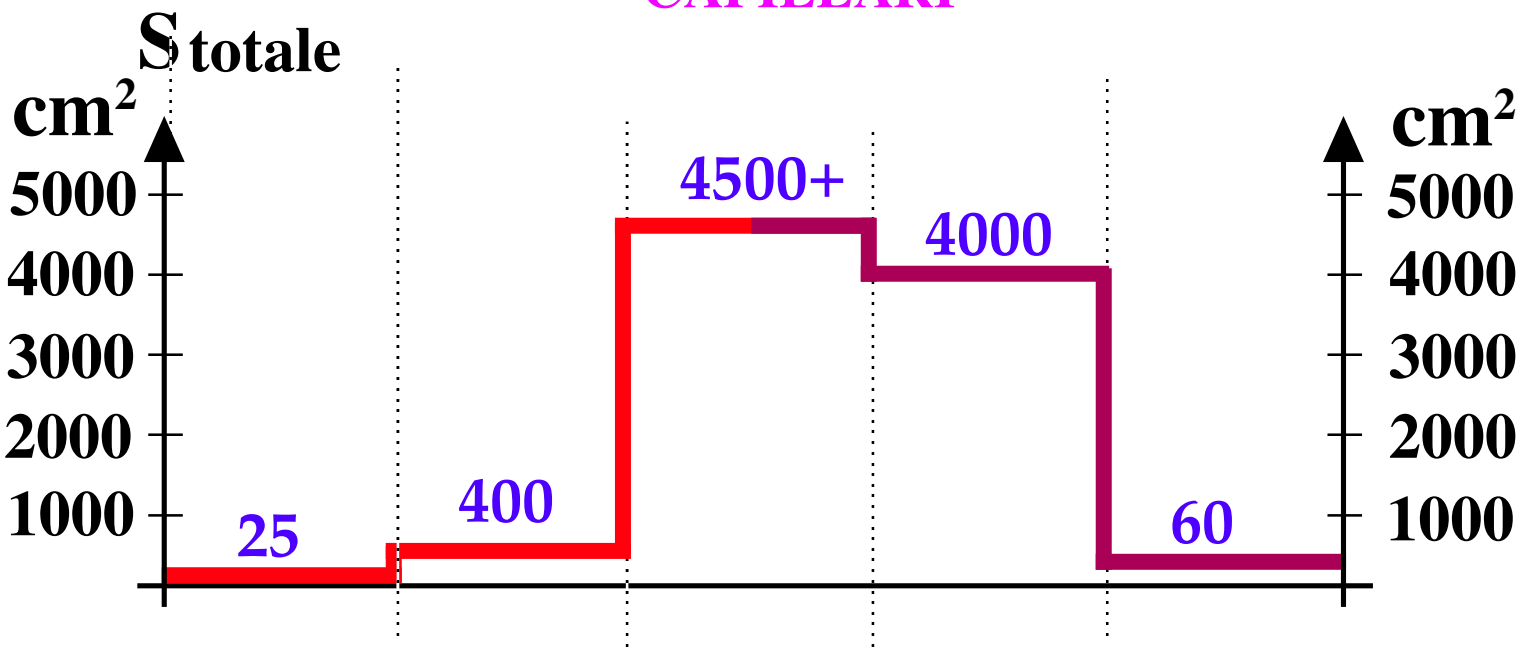
S = 5 cm²
v = 20 cm s⁻¹

S = 1.25 cm²
v = 80 cm s⁻¹

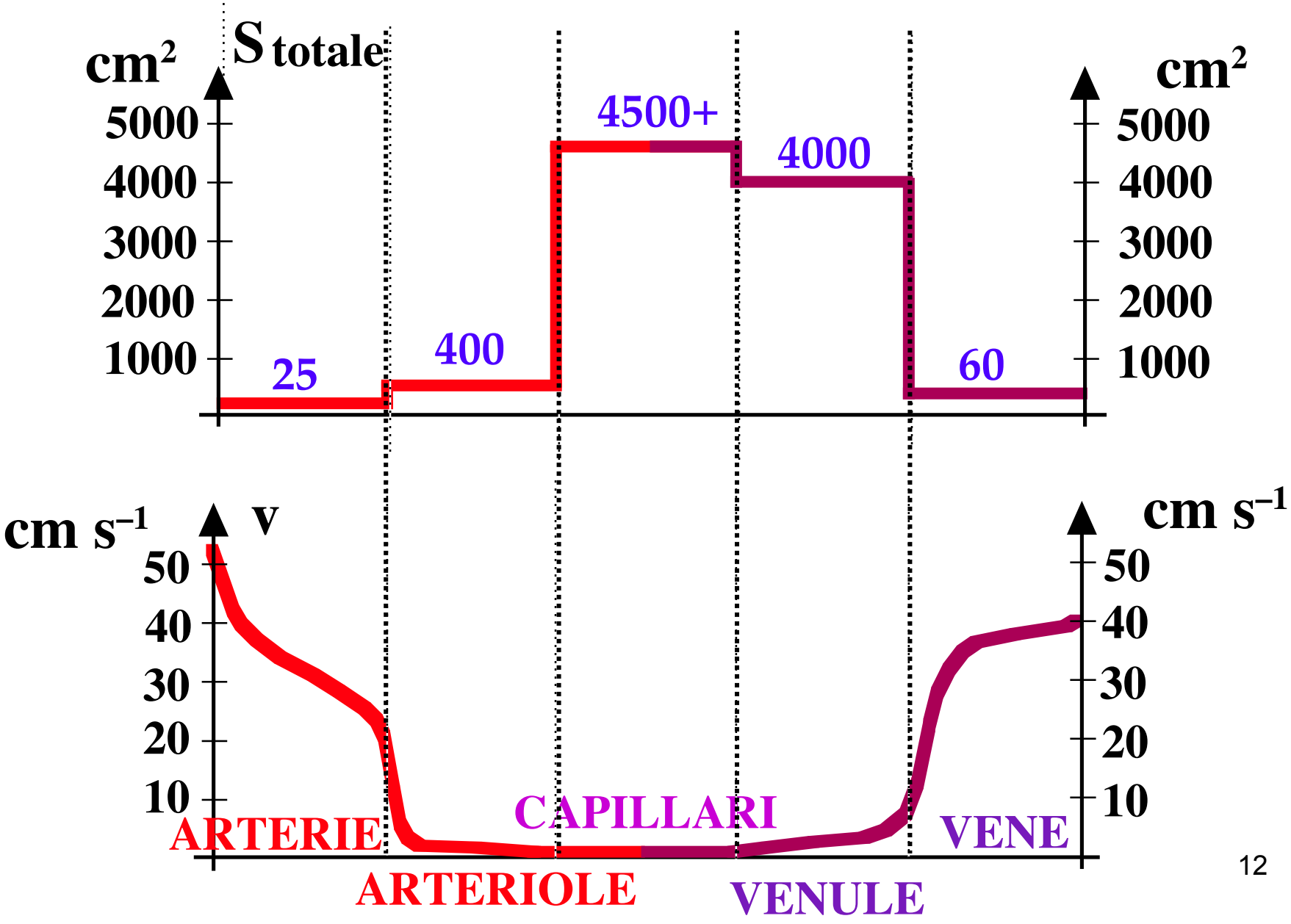
S = 2.5 cm²
v = 40 cm s⁻¹

NUMERO, SEZIONE, VELOCITA'





NUMERO, SEZIONE, VELOCITA'



EQUAZIONE di CONTINUITA': $Q = S_1 v_1 = S_2 v_2$

(tutti valori medi indicativi)

portata circolo: $Q \cong 5 \text{ litri min}^{-1} = \frac{5000 \text{ cm}^3}{60 \text{ s}} \cong 85 \text{ cm}^3 \text{ s}^{-1}$

AORTA $r = 0.8 \text{ cm} \longrightarrow S = \pi r^2 = 2.5 \text{ cm}^2$

$v = Q/S = 85/2.5 \text{ cm s}^{-1} \cong 42.5 \text{ cm s}^{-1}$

ARTERIOLE $S = 400 \text{ cm}^2$

$v = Q/S = 85/400 \text{ cm s}^{-1} \cong 0.2 \text{ cm s}^{-1} = 2 \text{ mm s}^{-1}$

CAPILLARI $S = 4500 \text{ cm}^2$

$v = Q/S = 85/4500 \text{ cm s}^{-1} \cong 0.02 \text{ cm s}^{-1} = 0.2 \text{ mm s}^{-1}$

VENA CAVA $S = 4 \text{ cm}^2$

$v = Q/S = 85/4 \text{ cm s}^{-1} \cong 21 \text{ cm s}^{-1}$