Physiology

Lec 10

Basel Ayman

Haemodynamics and capillary filtration

لا تنسى اهل غزة

أكثر من 35000 شهيد

+150000 مصاب

20000 فاقد احد الوالدين

2.1 مليون محاصر جائع

Exchange occurs in capillary
thats why its consist of
Single cell layer

No elastic
NO smooth muscle

Just have epithelial cells that contains Pores

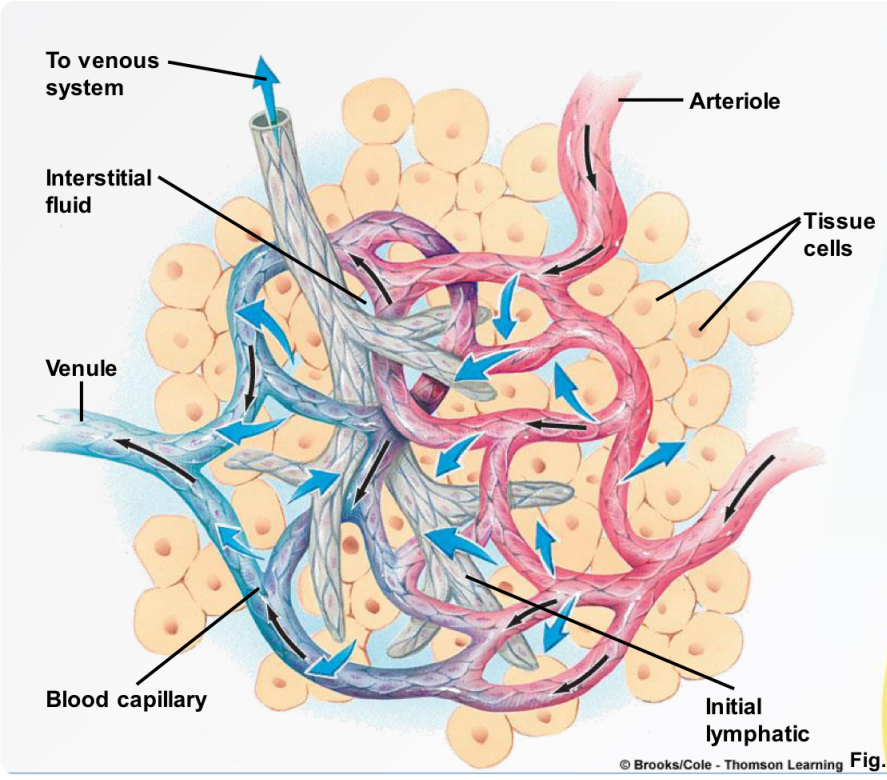


Fig.

Allow crossing of small molecules
like:-water, glucose, Amino Acid

All gases could cross cell membrane of anybody organ
why? Because the gases are lipid soluble molecules

The factor that control gas movement is partial pressure → high pressure ↓ low pressure of the gas

The factor that control ions movement is concentration gradient of the ion

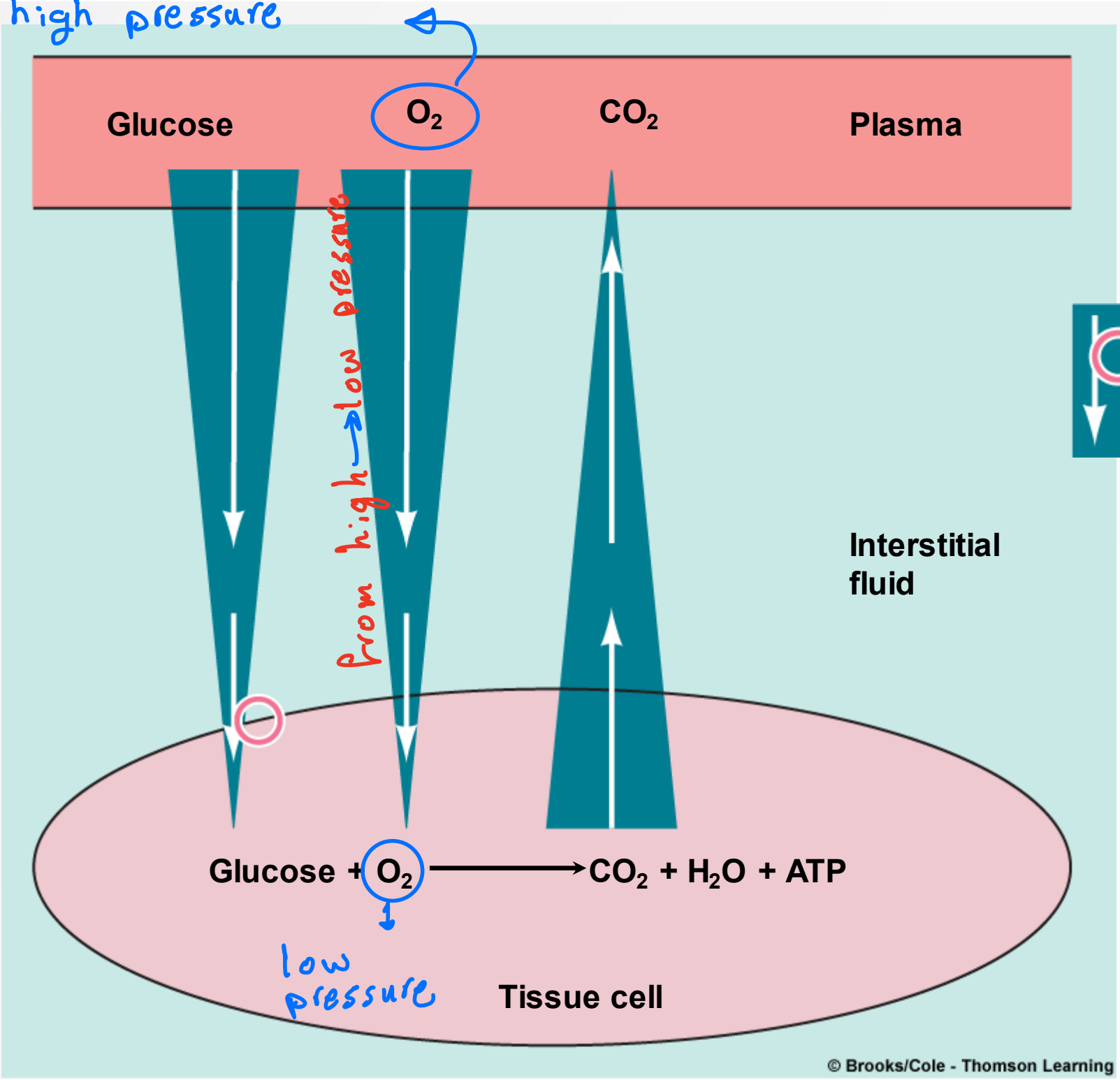


Fig. 10-17, p. 293

Capillary

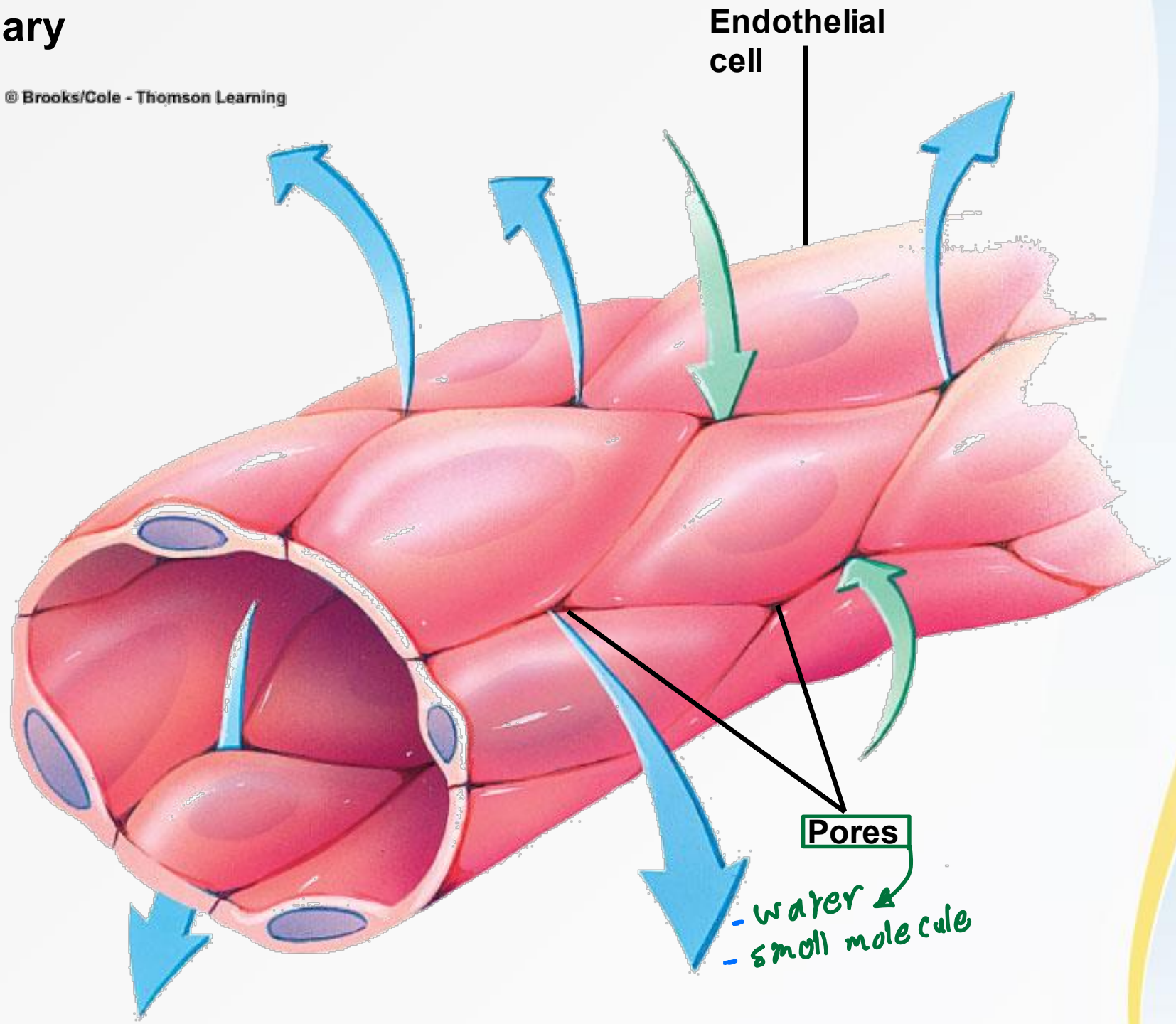


Fig. 10-16a, p. 292

Types of pores: Majority of Capillaries have pores

But some organs have special type of pores

In some organs the pores in the capillaries have special characteristics .

شرح النقطة بالسلايد يلي تحت

1- In ***Brain*** the junctions between the capillary endothelial cells are tight junctions allowing only very small molecules to pass into brain cells, e.g oxygen CO_2, glucose and water

2- In ***liver*** the clefts between the endothelial cells are wide open to allow almost all plasma components to pass including large molecular weight proteins → Globulin, Albumin

3- In ***Kidney*** the glomerular tufts have large number of oval like windows called " ***fenestrae*** " which penetrate all through the endothelial wall which allows all components of plasma to filter out except large molecular weight proteins (albumin) and blood elements (blood white and red cells)

* **Not all components will excreted by urine almost they are reabsorption**

1- In ***Brain*** the junctions between the capillary endothelial cells are tight junctions allowing only very small molecules to pass into brain cells, e.g oxygen CO_2, glucose and water

in fact the brain does not allow any substance to cross except:- glucose → cross blood brain barrier

In very low glucose concentration Ketone could cross blood brain barrier ← Result of Fatty Acid meta bolsim

* Normal condition → glucose

* Emergency → Keton could pentrat

There are variations between capillaries types that facilitate each organ functions

There are two forces first one push fluid to filter out the Capillaries and the second force Reabsorped Fluid

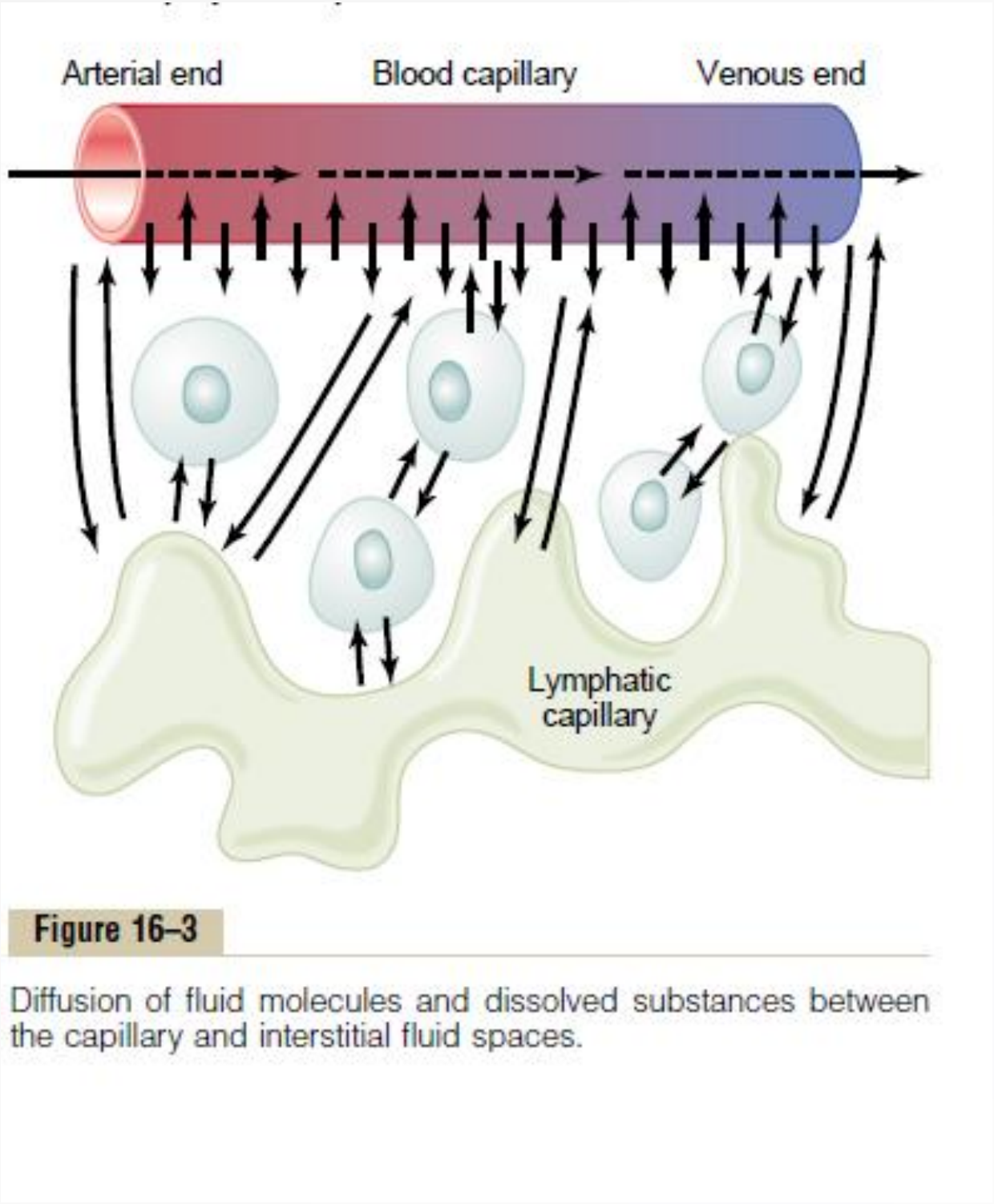


Figure 16–3

Diffusion of fluid molecules and dissolved substances between the capillary and interstitial fluid spaces.

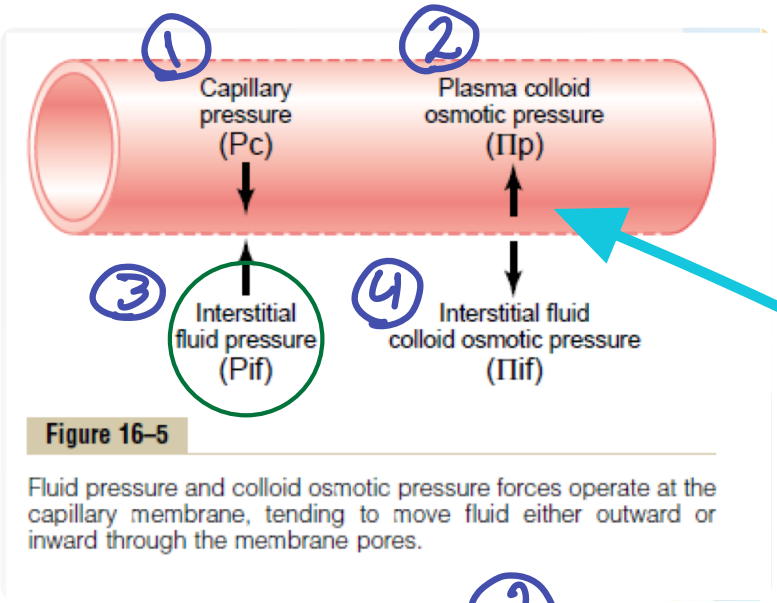


Figure 16–5

Fluid pressure and colloid osmotic pressure forces operate at the capillary membrane, tending to move fluid either outward or inward through the membrane pores.

End of capillary blood pressure is 20mm

1

beginning of capillary blood pressure is (**40mm**) which called **capillary hydrostatic pressure**(come from blood pressure), that filtrate and push fluids and substances out the capillary

2

in the another hand protein that could not Penetrate the capillary and still inside as (**Albumin**, **globulin**) make pressure that called **colloid pressure**(**25-27mm**) that influx fluid and substance to capillary and reabsorption occurs

3

interstitial fluid pressure (**1mm**)
:- high water in the interstitial lead to increase water pressure this pressure push fluid back to capillary but this mechanism have low contribute

4

interstitial colloid osmotic pressure (**zero**) occurs by protein around capillary lead to push fluid out capillary the mechanism did not effect ≈ zero

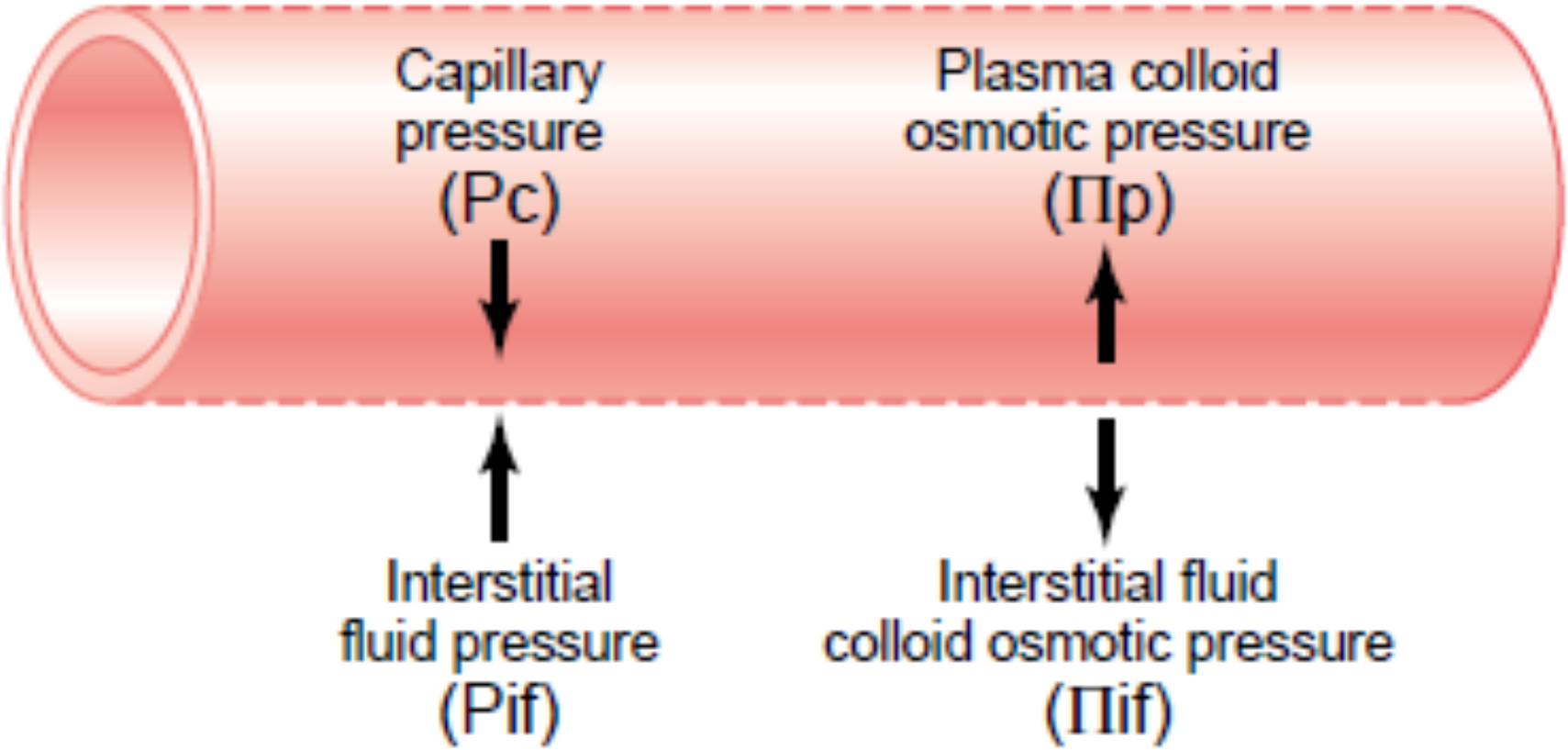


Figure 16–5

Fluid pressure and colloid osmotic pressure forces operate at the capillary membrane, tending to move fluid either outward or inward through the membrane pores.

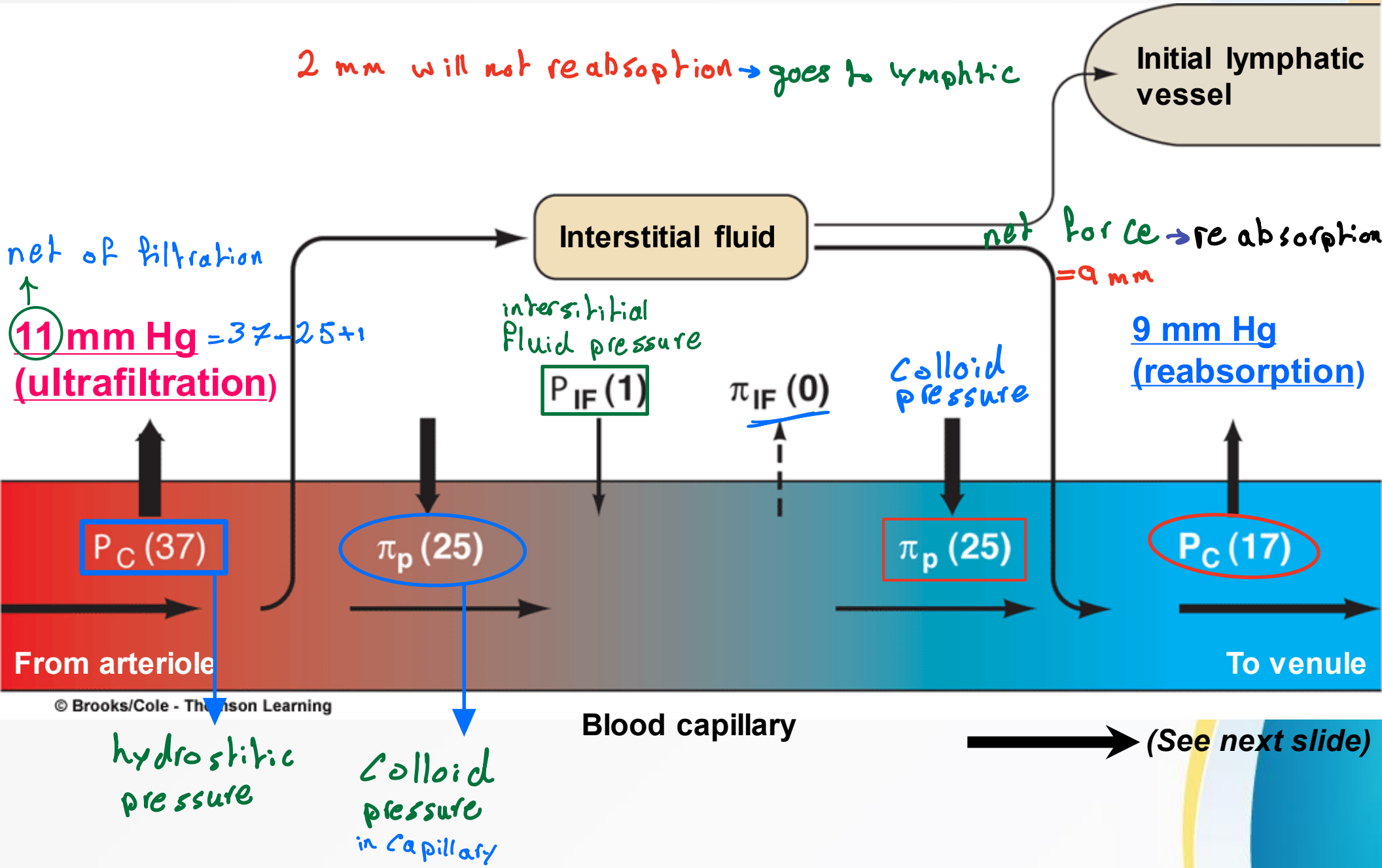
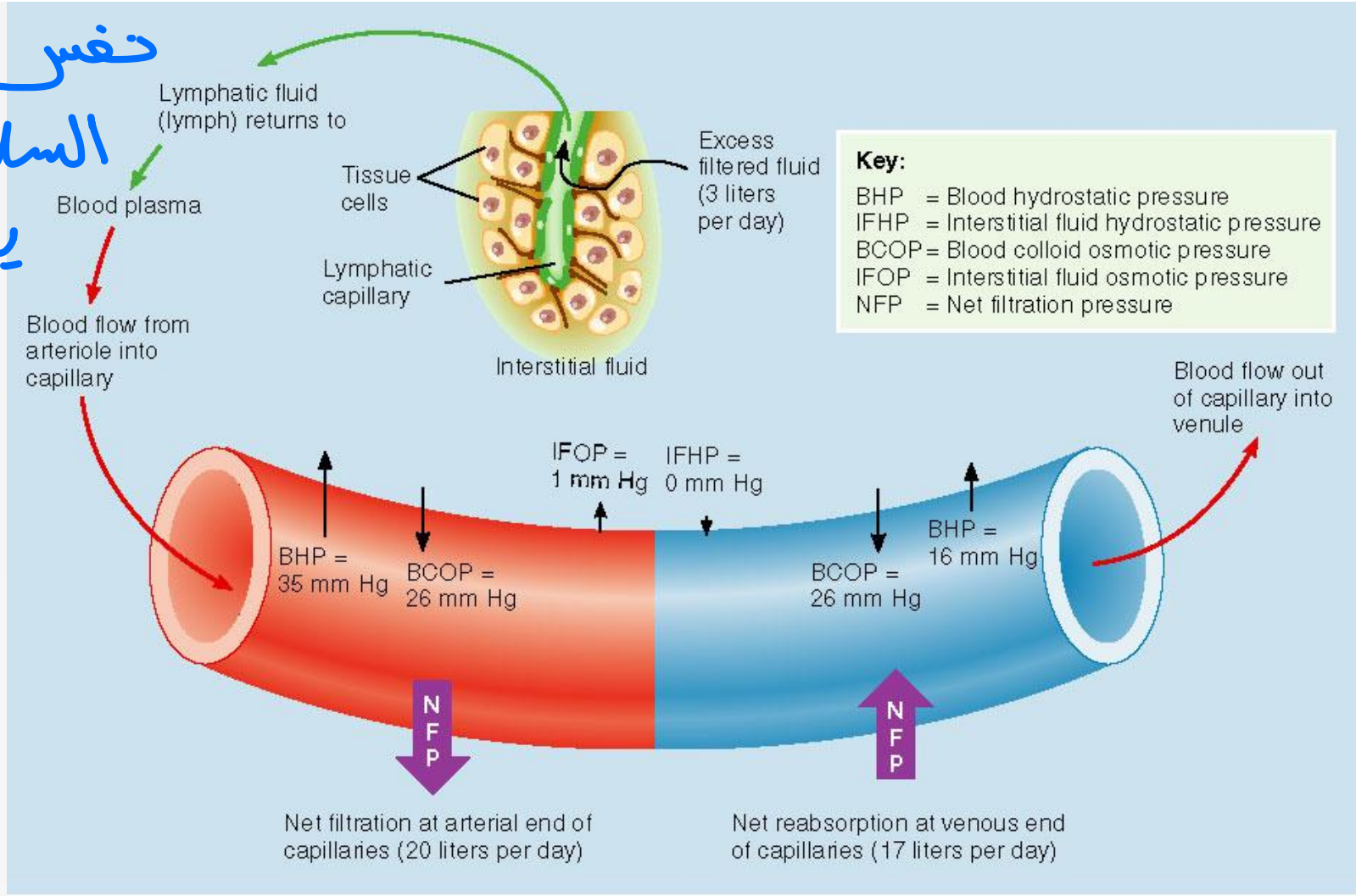


Fig. 10-18 (middle), p. 294

حفس السلايد يلي فوق



Net filtration pressure (NFP)	=	(BHP + IFOP)	–	(BCOP + IFHP)
		Pressures promoting filtration		Pressures promoting reabsorption
		Arterial end		**Venous end**
		NFP = (35 + 1) – (26 + 0) = 10 mm Hg		NFP = (16 + 1) – (26 + 0) = – 9 mm Hg
Result		Net filtration		Net reabsorption

Forces at arteriolar end of capillary

تفصيل للشرح يلي فوق

- **Outward pressure**

P_c	37
π_{IF}	+ 0
	37

- **Inward pressure**

π_P	25
P_{IF}	+ 1
	26

Net outward pressure of 11 mm Hg = Ultrafiltration pressure

(See next slide)

All values are given in mm Hg.

Forces at venular end of capillary

تفصيل للشرح يلي فوق

- **Outward pressure**

P_C	17
π_{IF}	+ 0
	17

- **Inward pressure**

π_P	25
P_{IF}	+ 1
	26

Net inward pressure of 9 mm Hg = Reabsorption pressure

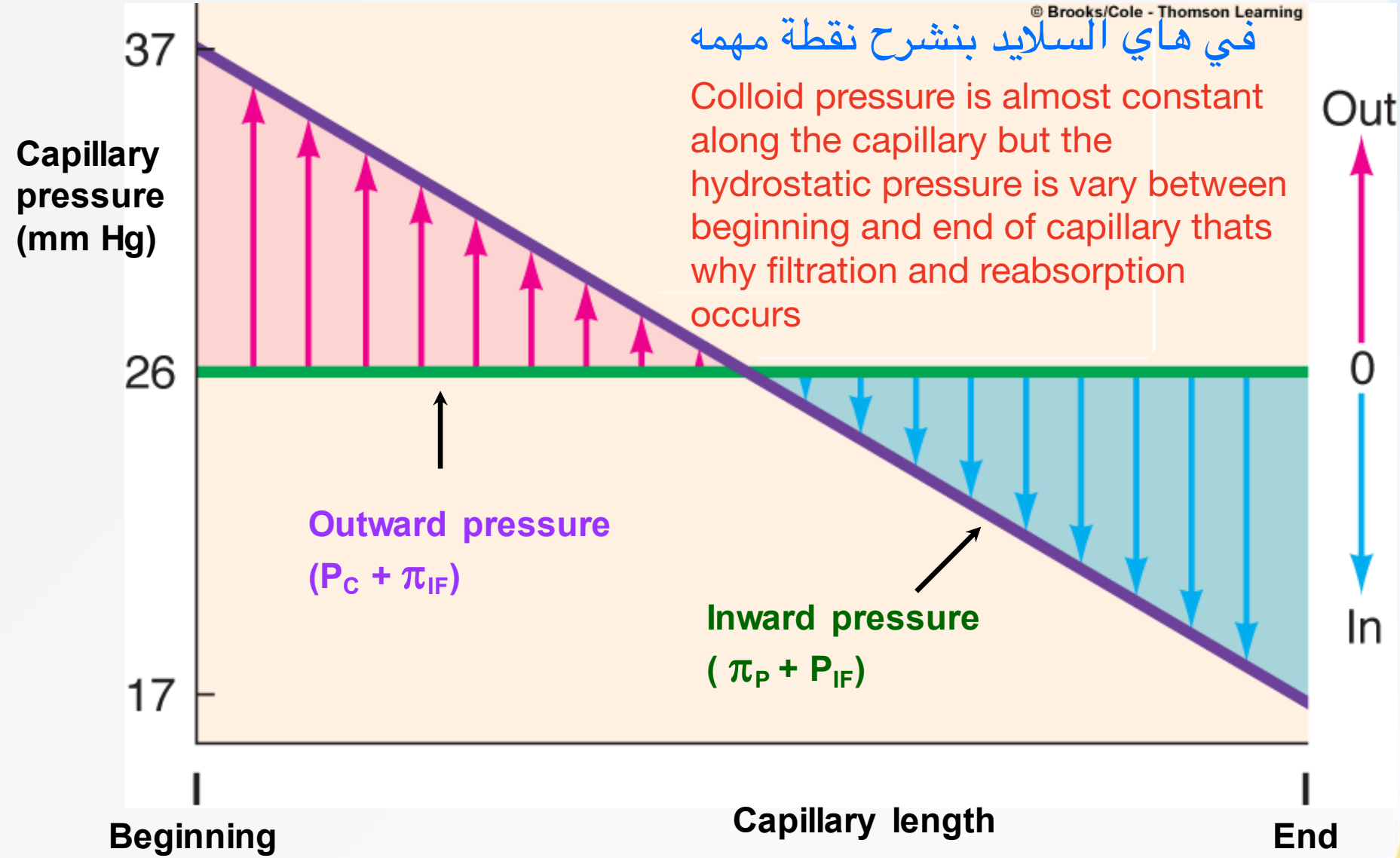
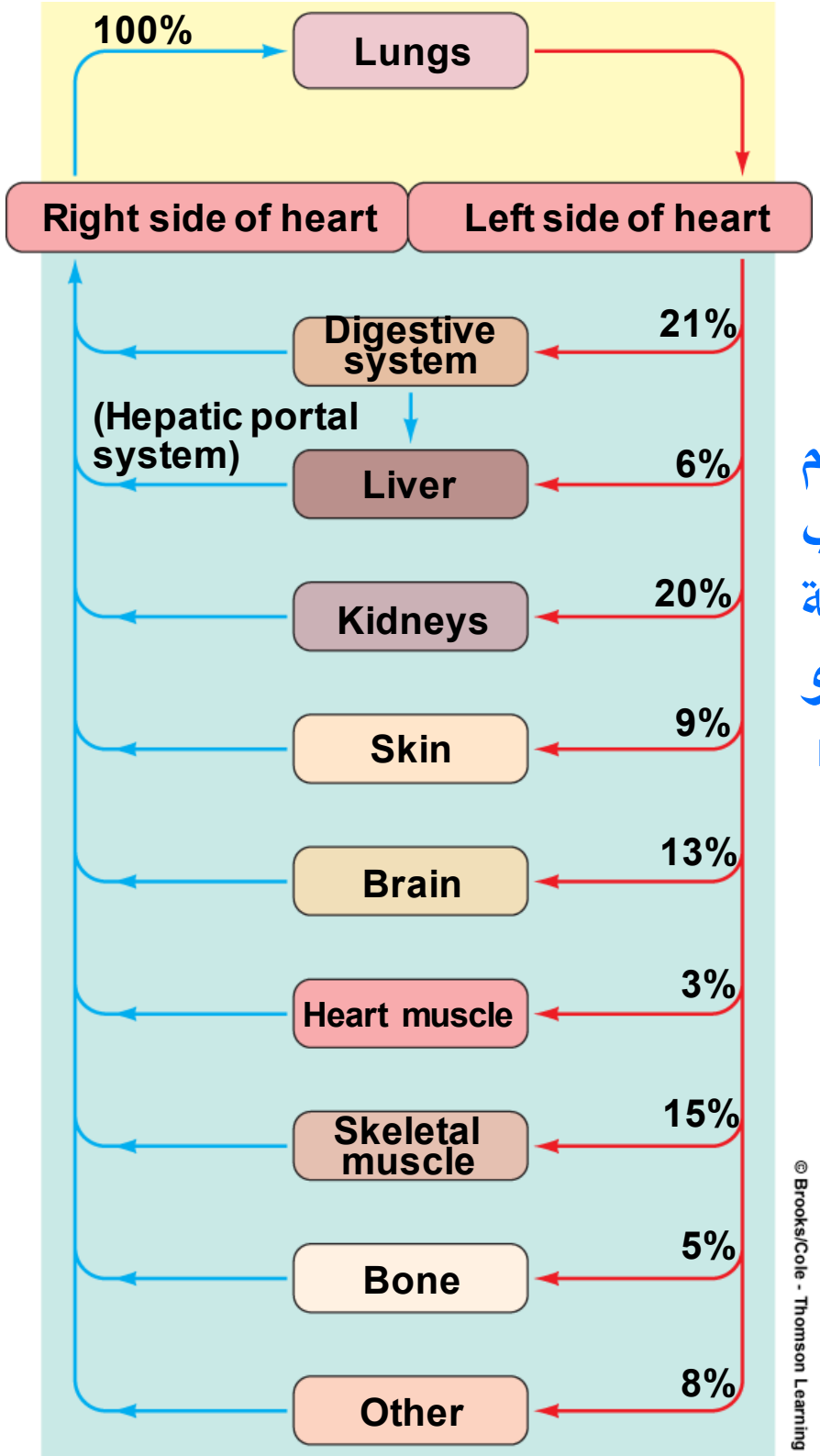


Fig. 10-19, p. 295

الارقام مش حفظ



اعلى جزء يصله دم مقارنة بوزن العضو هو

aortic body

Carotid body

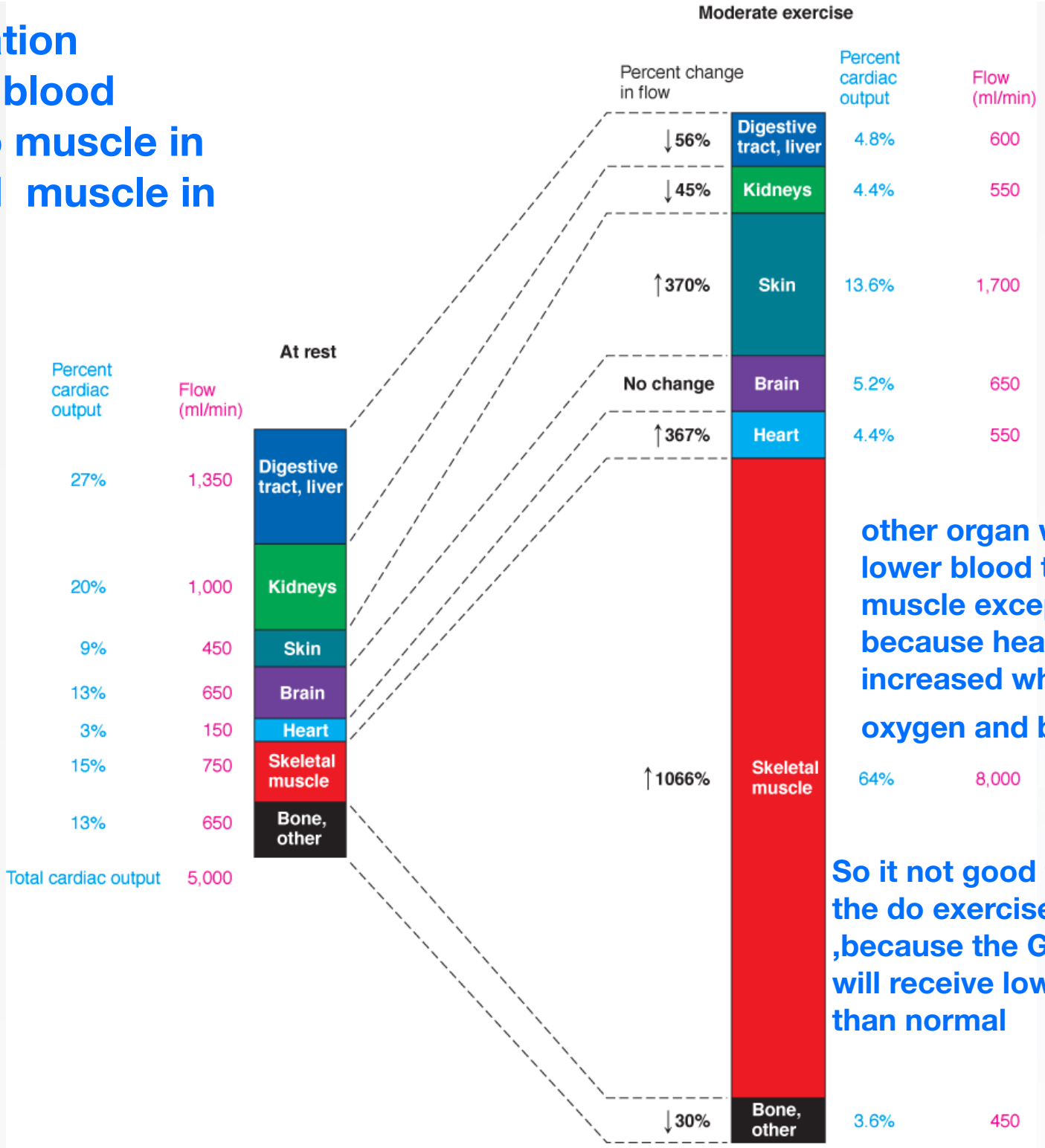
Because they are sensitive to partial oxygen pressure not hemoglobin binding oxygen

If the person inhaled CO, it will bind to hemoglobin and the chemoreceptors will not recognise it

الاختلاف بنسب الدم الواصل للأعضاء بسبب اختلاف الاهمية الوظيفية و metaboli activity

Fig. 10-1, p. 276

The variation between blood supply to muscle in relax and muscle in exercise



other organ will receive lower blood to supply the muscle except the heart, because heart rate is increased which needs more oxygen and blood supply

So it not good to eat and the do exercise ,because the GI system will receive lower blood than normal

Fig. 10-11, p. 286

Determinants of Blood Flow

#7/OCT

اعلى و اقوى مقاومه هي في غزة و
الكلام بالسلايد هذا خيال علمي و شكرا

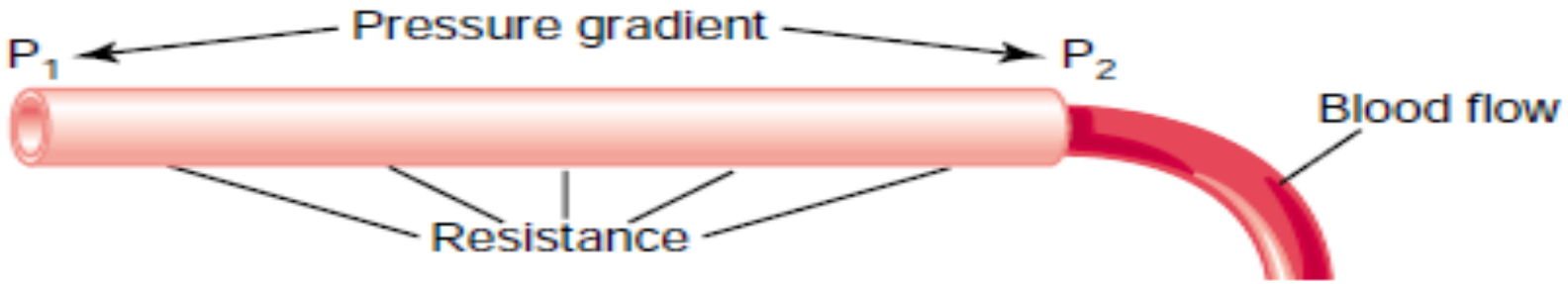


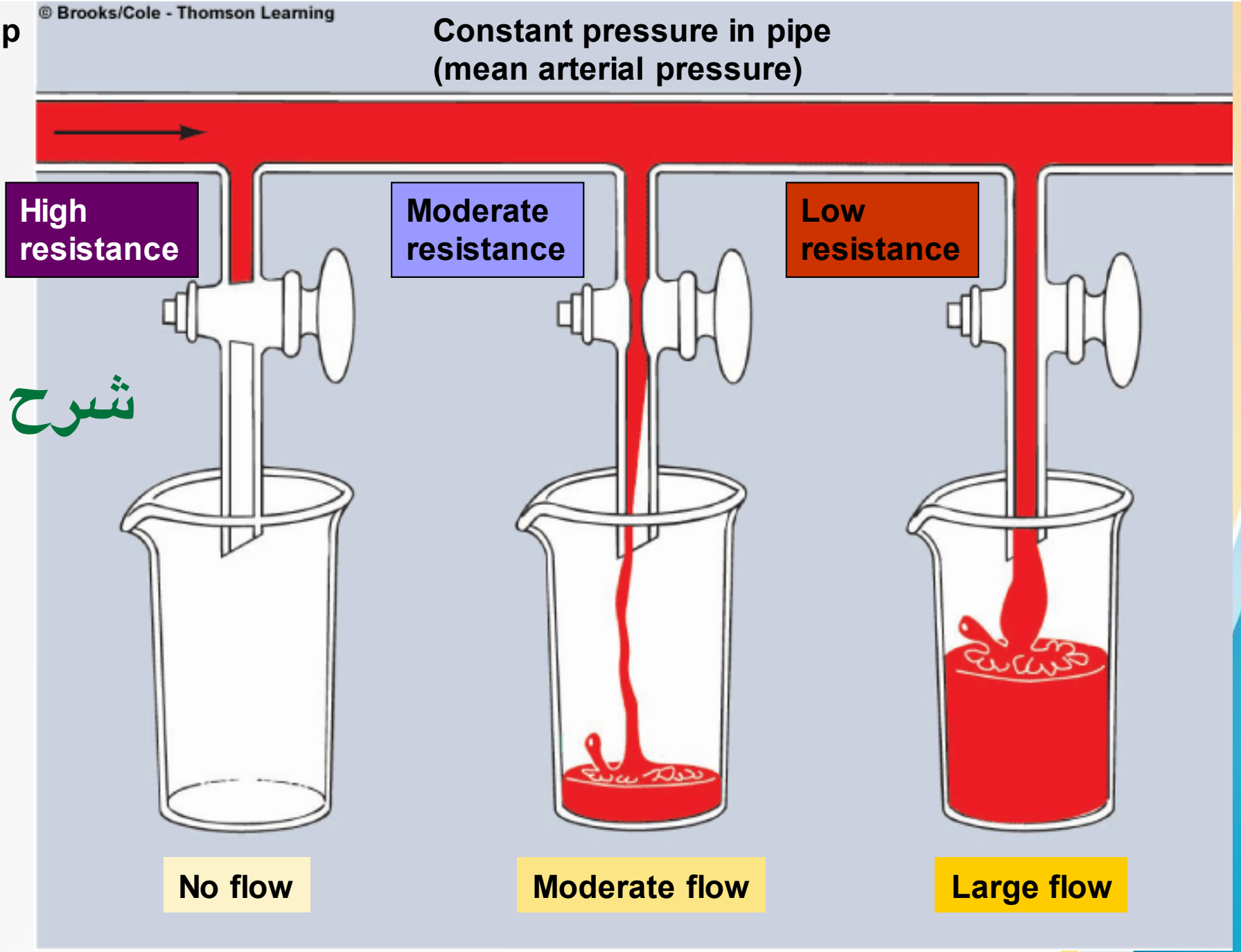
Figure 14–3

Interrelationships among pressure, resistance, and blood flow.

- Blood flow is determined by pressure gradient (1) and peripheral resistance (2), therefore: $F = \frac{(P_A - P_V)}{R}$
- Arterioles play a major role in blood distribution & control of BP.
- Arteriolar smooth muscles determine the resistance to blood flow to the tissues it supplies.

Called **Resistance vessels**

This occurs because of smooth muscle that is effected by sympathetic nerve lead to vasoconstriction which increases resistance



شرح للكلام

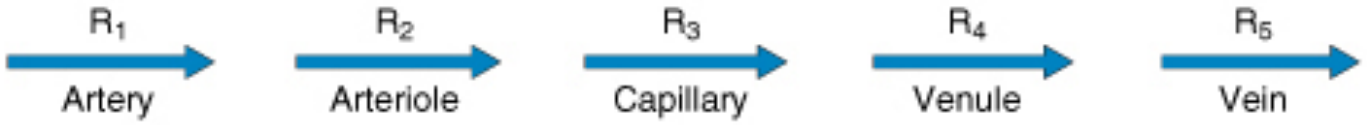
Control valves = Arterioles

Fig. 10-10, p. 285

SERIES RESISTANCES

على التوالي
وهكذا في جسم الانسان

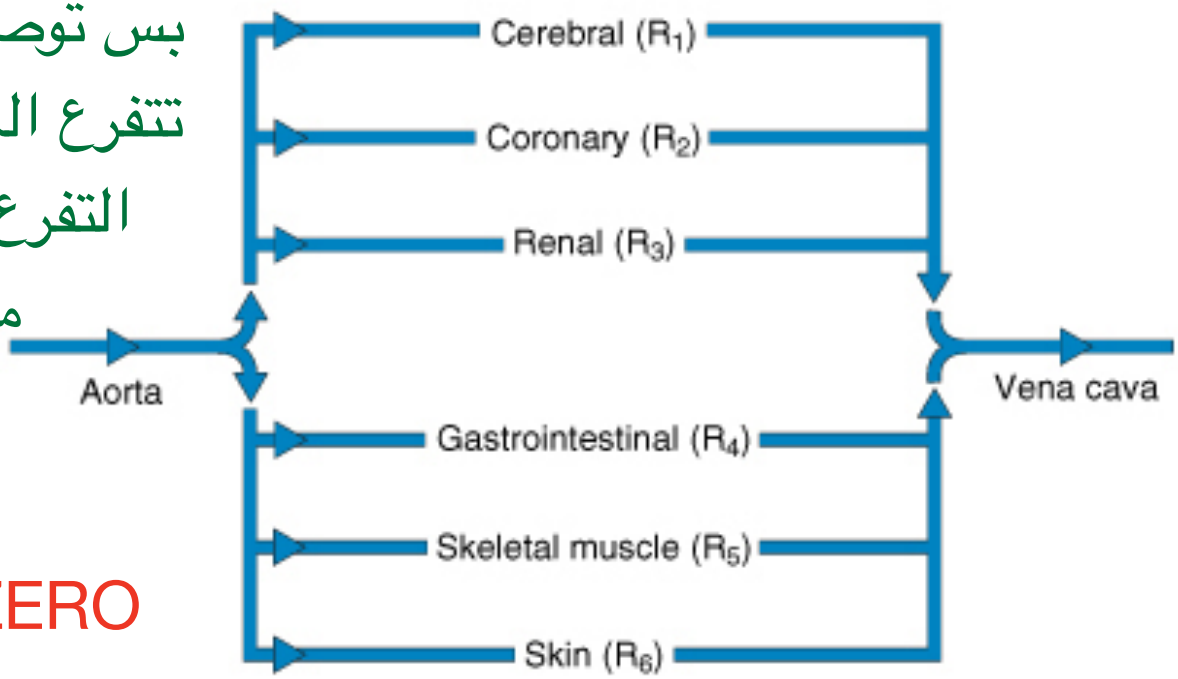
$$R_{total} = R_1 + R_2 + R_3 + R_4 + R_5$$



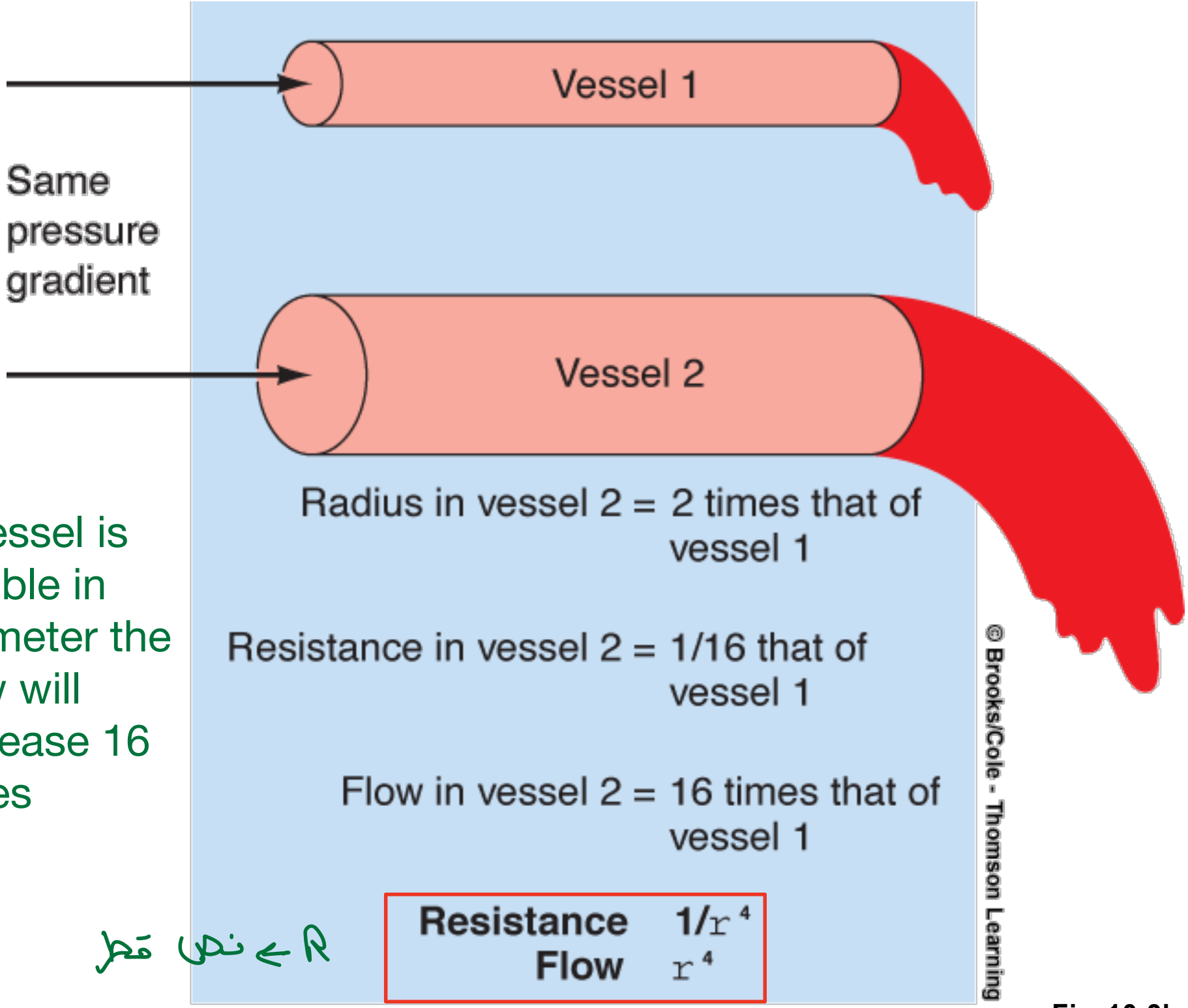
PARALLEL RESISTANCES

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6}$$

Arterioles بس توصل نهايه
تتفرع الى capillaries وهذا
التفرع يكون على التوازي و
مقاومه اقل من التوالي



Resistance in capillaries approximately ZERO

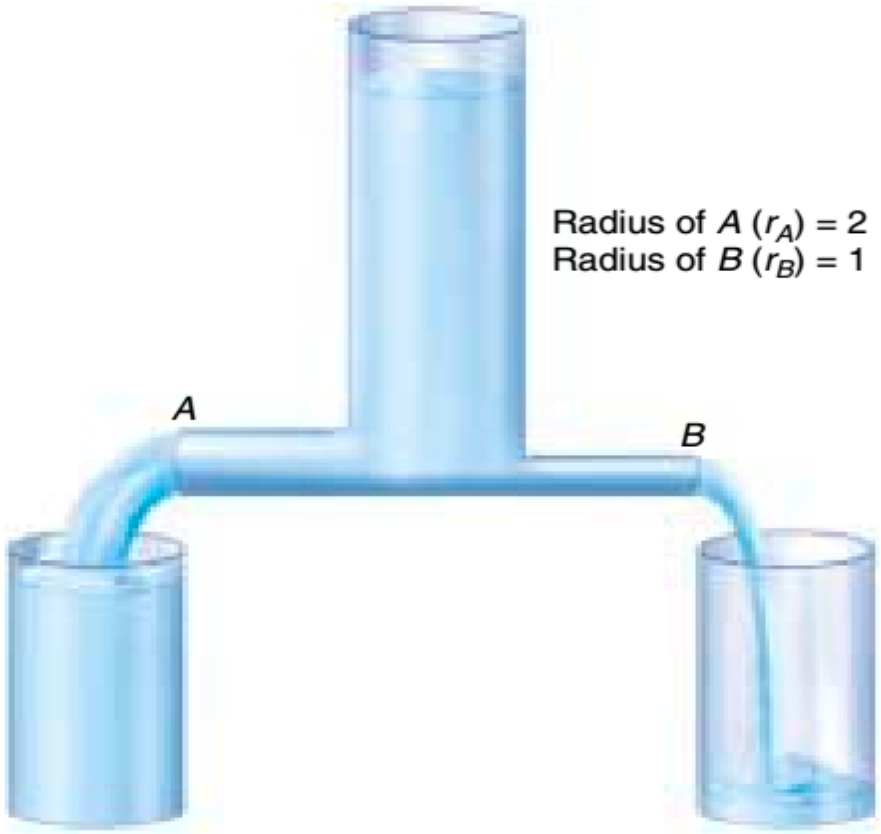


If vessel is double in diameter the flow will increase 16 times

R ← نص قطر

Fig. 10-3b, p. 278

نفس الفكرة



$$R \propto \frac{1}{r^4}$$

$$R_A \propto \frac{1}{(r_A)^4} = \frac{1}{2^4} = \frac{1}{16} = 0.0625$$

$$R_B \propto \frac{1}{(r_B)^4} = \frac{1}{1^4} = \frac{1}{1} = 1.0$$

Therefore $R_B = 16\ R_A$

$$\text{Flow} = \frac{\Delta P}{R}$$

Therefore flow in $B = \frac{1}{16}$ th of flow in A

نفس الفكرة

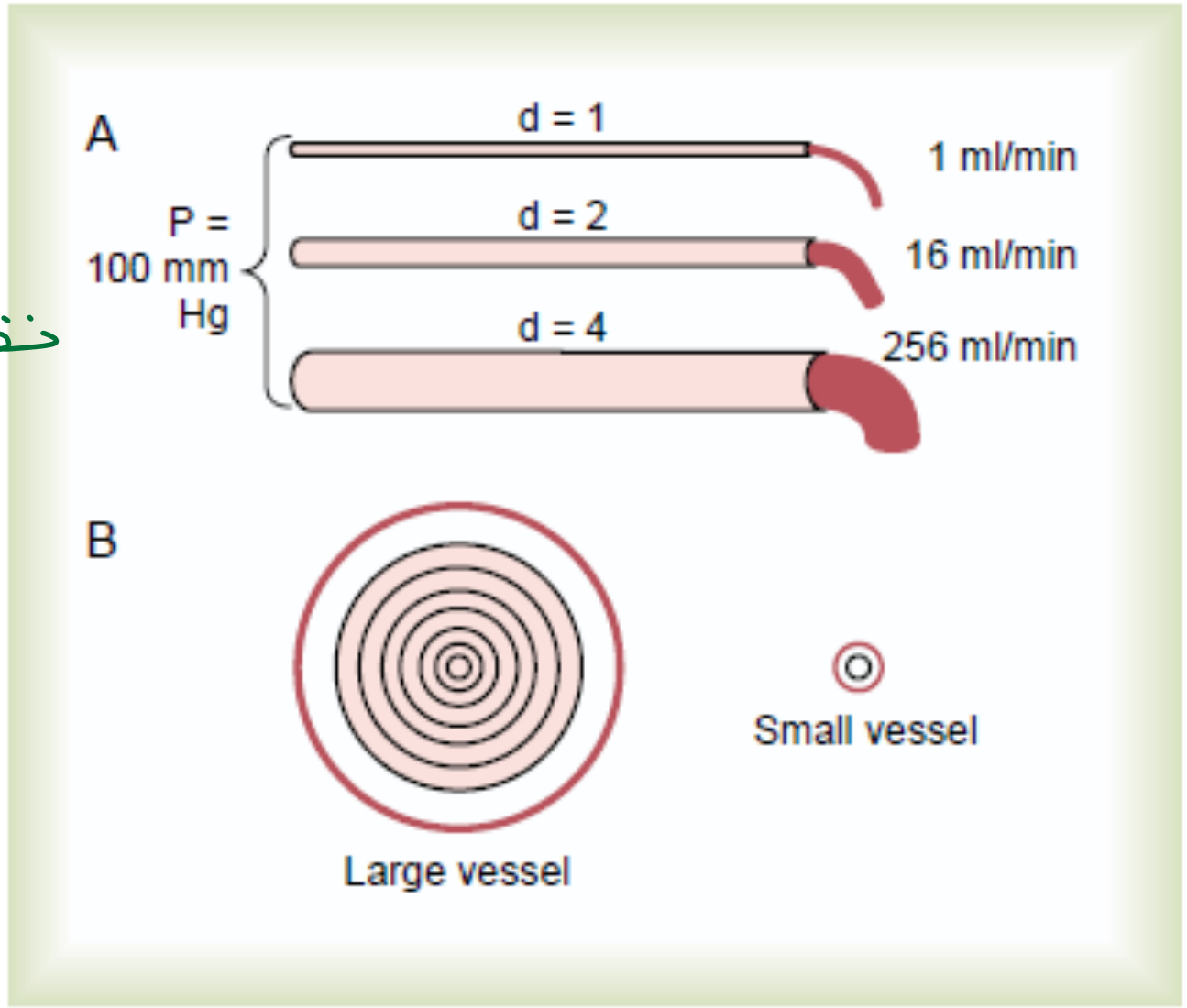


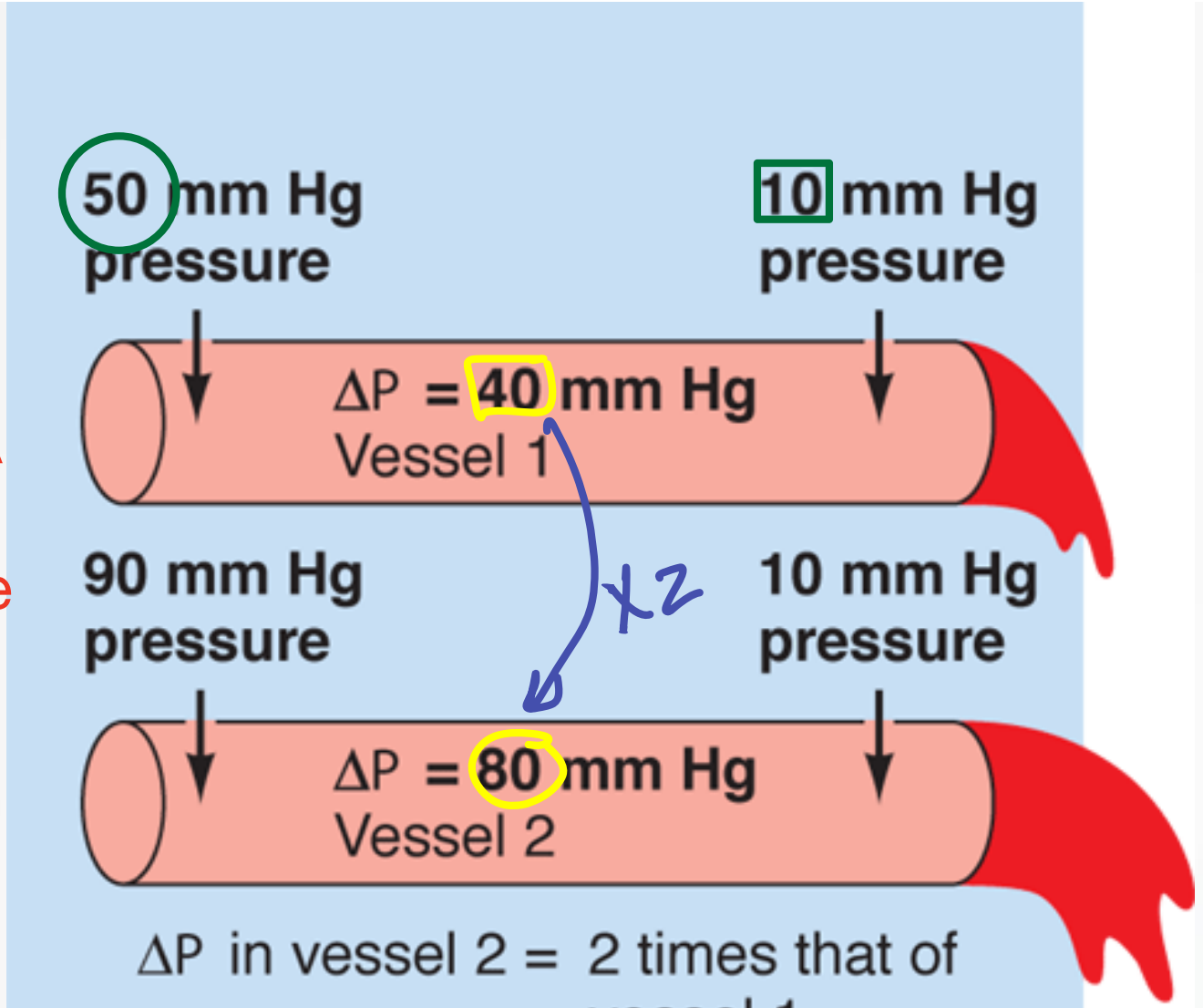
Figure 14–9

A, Demonstration of the effect of vessel diameter on blood flow. *B*, Concentric rings of blood flowing at different velocities; the farther away from the vessel wall, the faster the flow.

$F = \frac{P}{R}$

Increase in Δ pressure increases the flow

Flow and Δpressure is directly proportional



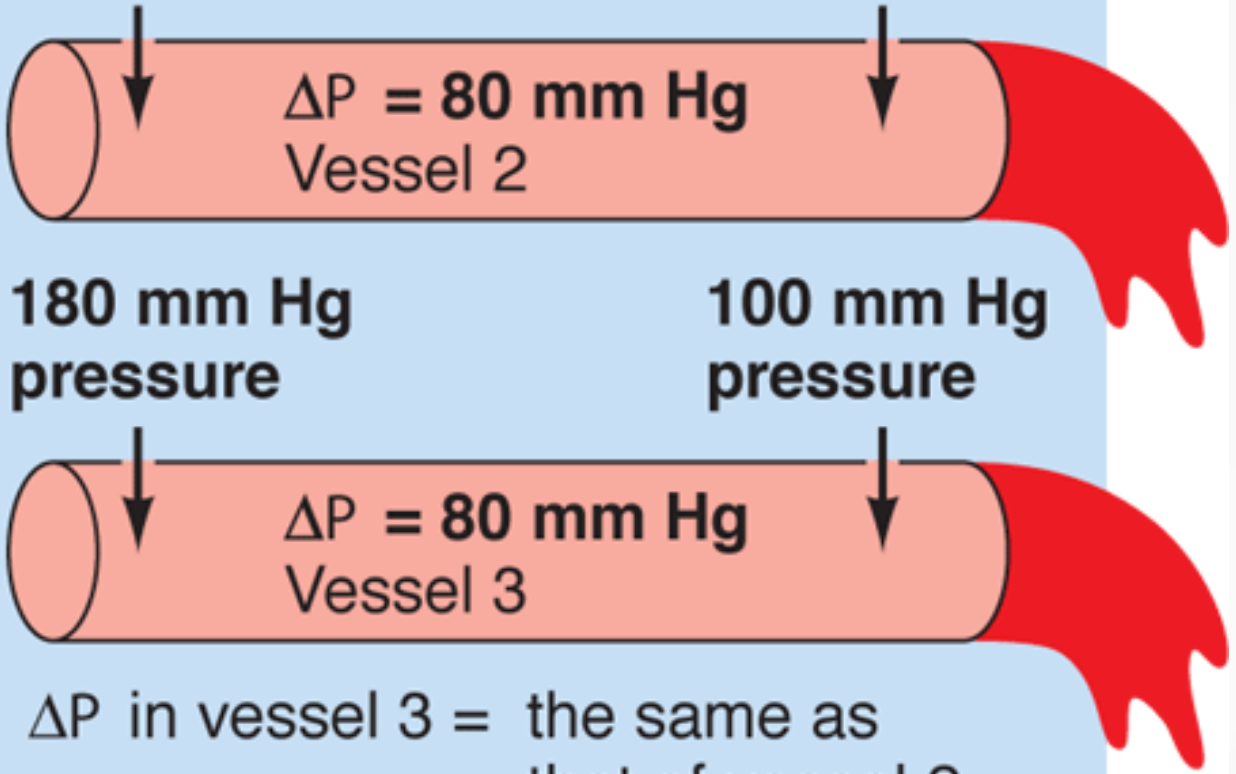
ΔP in vessel 2 = 2 times that of vessel 1

Flow in vessel 2 = 2 times that of vessel 1

Flow ~ ΔP

Fig. 10-2a, p. 277

You should focus on difference between pressure not the value



ΔP in vessel 3 = the same as that of vessel 2, despite the larger absolute values

Flow in vessel 3 = the same as that of vessel 2

Flow ~ ΔP

Fig. 10-2b, p. 277

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

Since **R**esistance α 1/r4 (radius to power 4)…r = radius

عكسي

R inversely proportional to r4

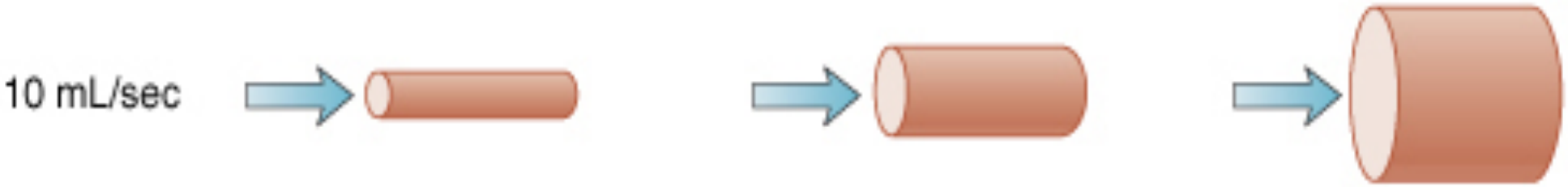
Therefore **F = ΔP x r4**

Hence: If the **radius is doubled** the **flow will increase by 16 times**

The relationship between velocity, flow and cross sectional area

V = velocity cm/sec, Q = flow ml/sec, A = cross sectional area

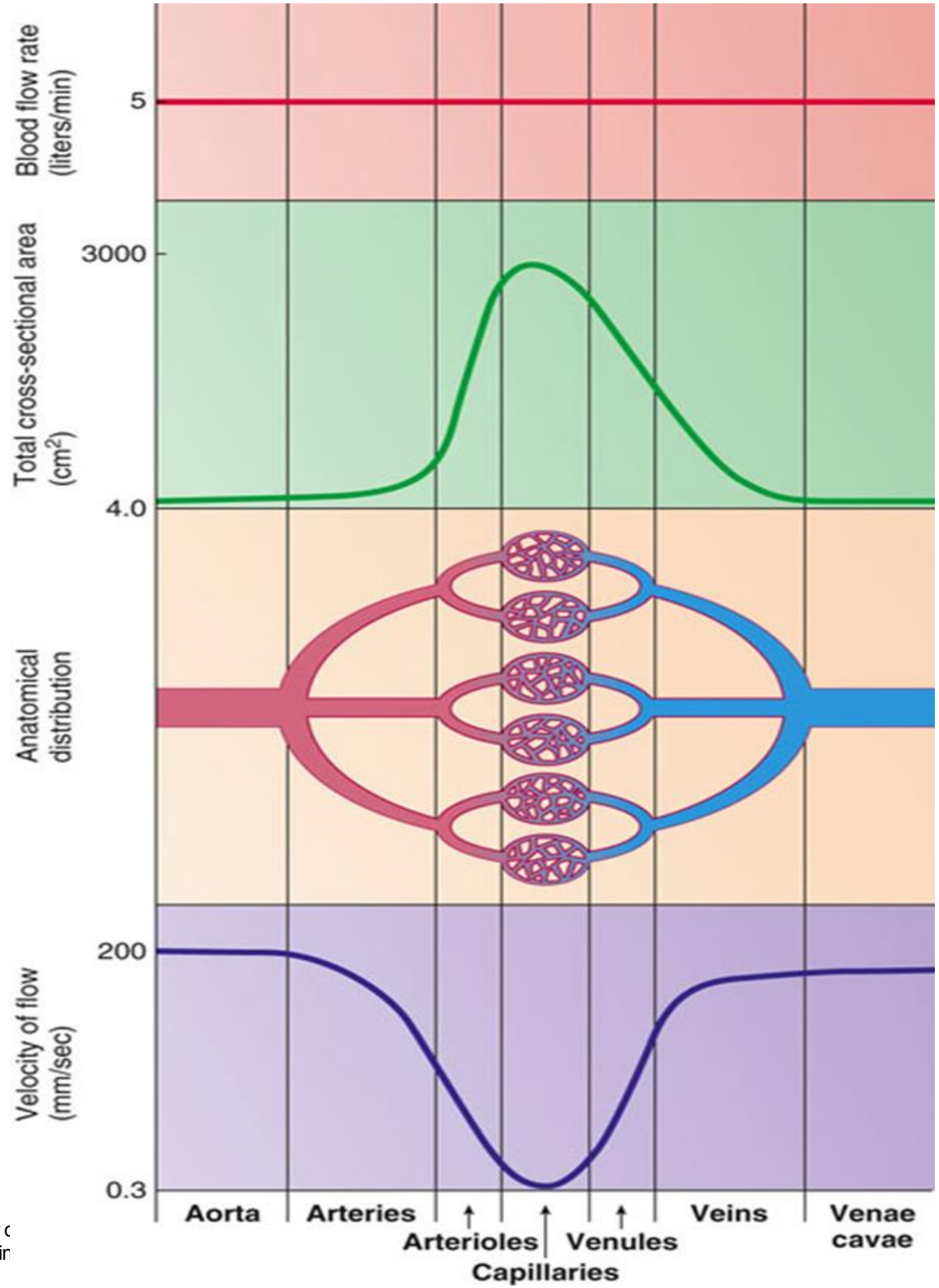
$$v = Q/A$$



Area (A)	1 cm^2	10 cm^2	100 cm^2
Flow (Q)	10 mL/sec	10 mL/sec	10 mL/sec
Velocity (v)	**10 cm/sec**	**1 cm/sec**	**0.1 cm/sec**

The flow is the same in all vessels (aorta, artery, capillary, ……)

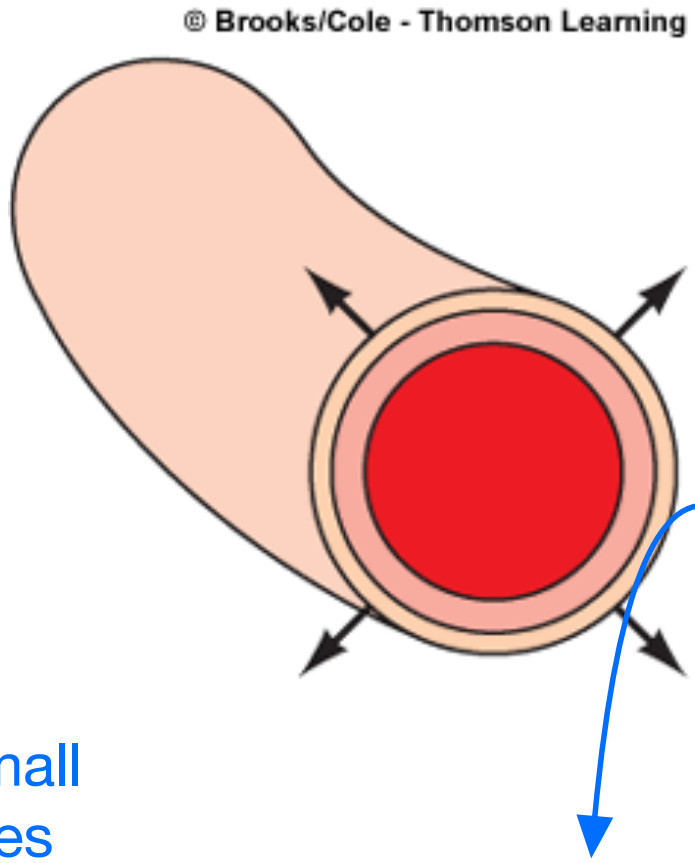
The capillary have lowest velocity because its had very low cross sectional area



Vasodilation

(decreased contraction of circular smooth muscle in the arteriolar wall, which leads to decreased resistance and increased flow through the vessel)

Any dilation or constriction in aorta will not make huge effect because it's already large, but small difference in arterioles make effect

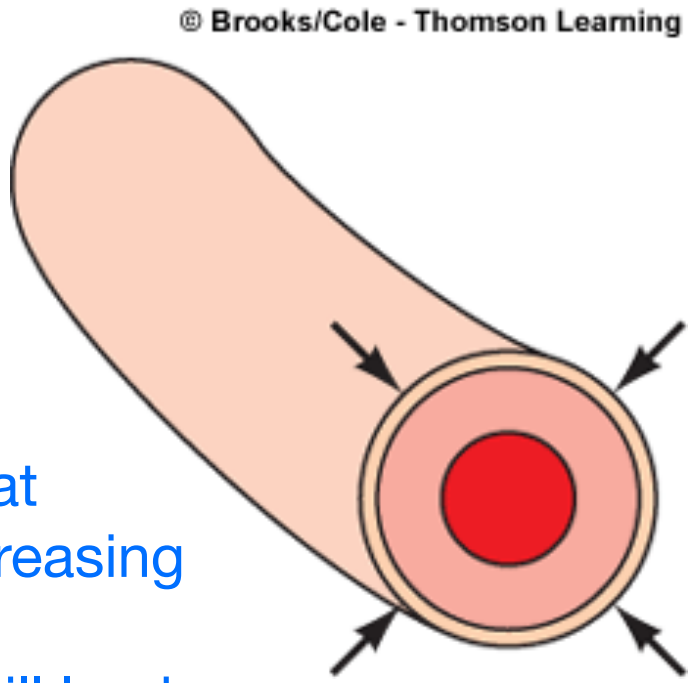


High metabolic activty lead to vasodilation which is local effect

Fig. 10-9d, p. 284

Vasoconstriction

(increased contraction of circular smooth muscle in the arteriolar wall, which leads to increased resistance and decreased flow through the vessel)



Caused by:

- ↑ **Myogenic activity**
- ↑ **Oxygen (O_2)**
- ↓ **Carbon dioxide (CO_2) and other metabolites**
- ↑ **Endothelin**
- ↑ **Sympathetic stimulation**
- **Vasopressin; angiotensin II**
- **Cold**

ADH ← Vasopressin; angiotensin II

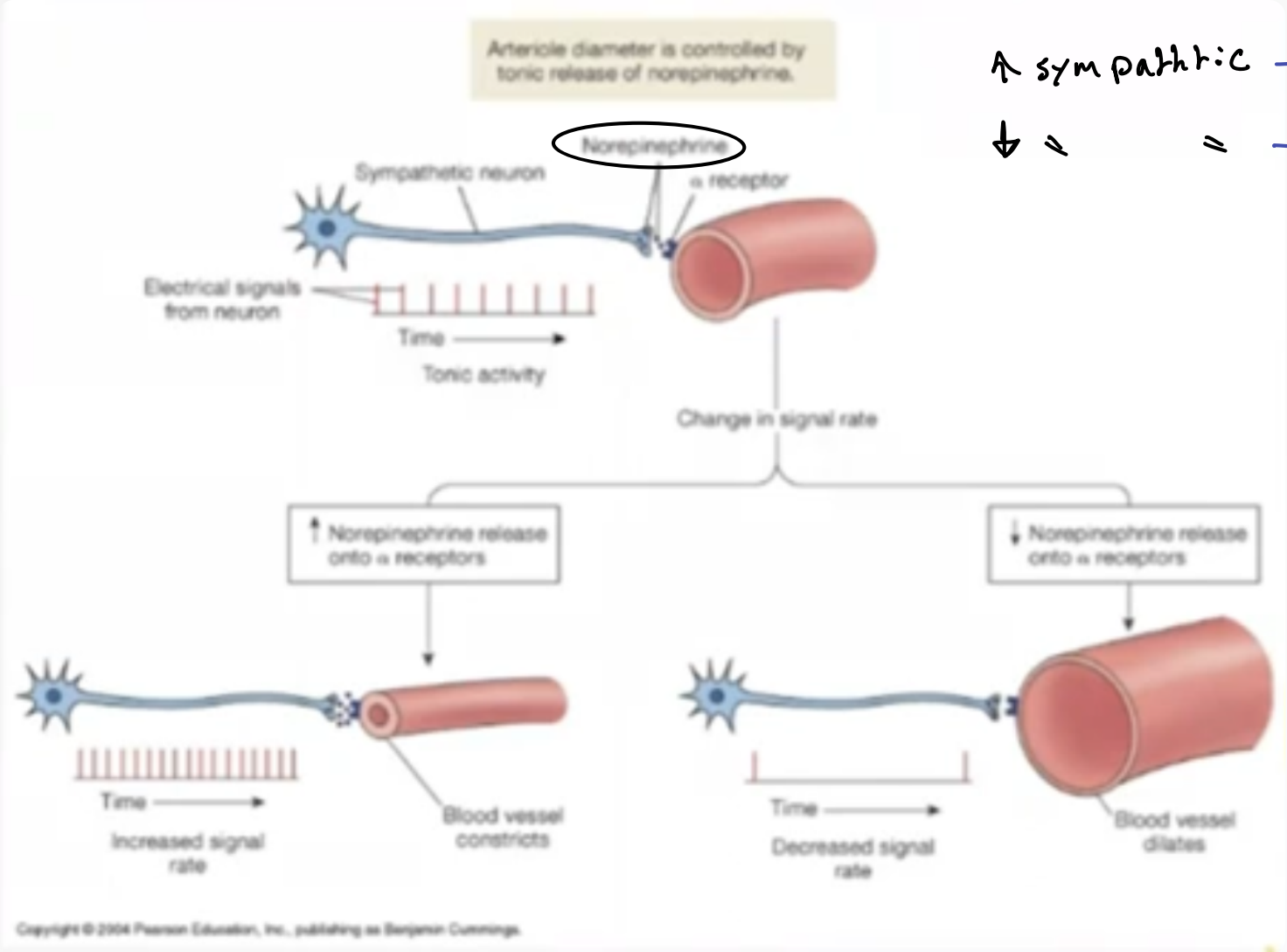
↓

if effect reabsorption of water in Kidney → ↑ Reabsorption

The vasoconstriction that occurs by cold and decreasing temperature is limited, reached 10 degrees it will lead to vasodilation rather vasoconstriction, because if continue constriction after 10 degrees the person will die by hypoxia

Fig. 10-9c, p. 284

Neural Regulation



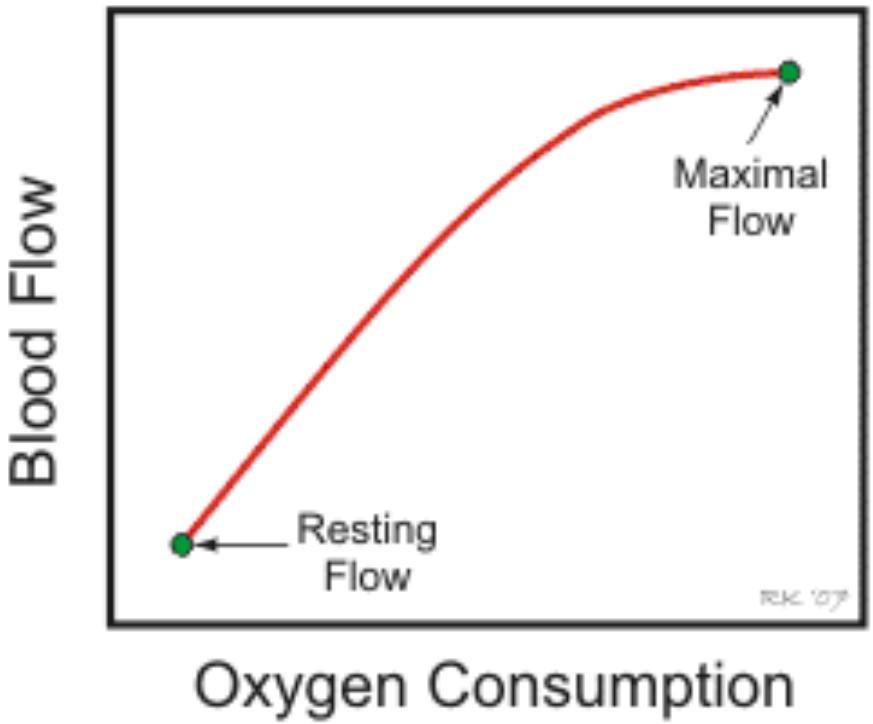
↑ sympathetic → vasoconstriction

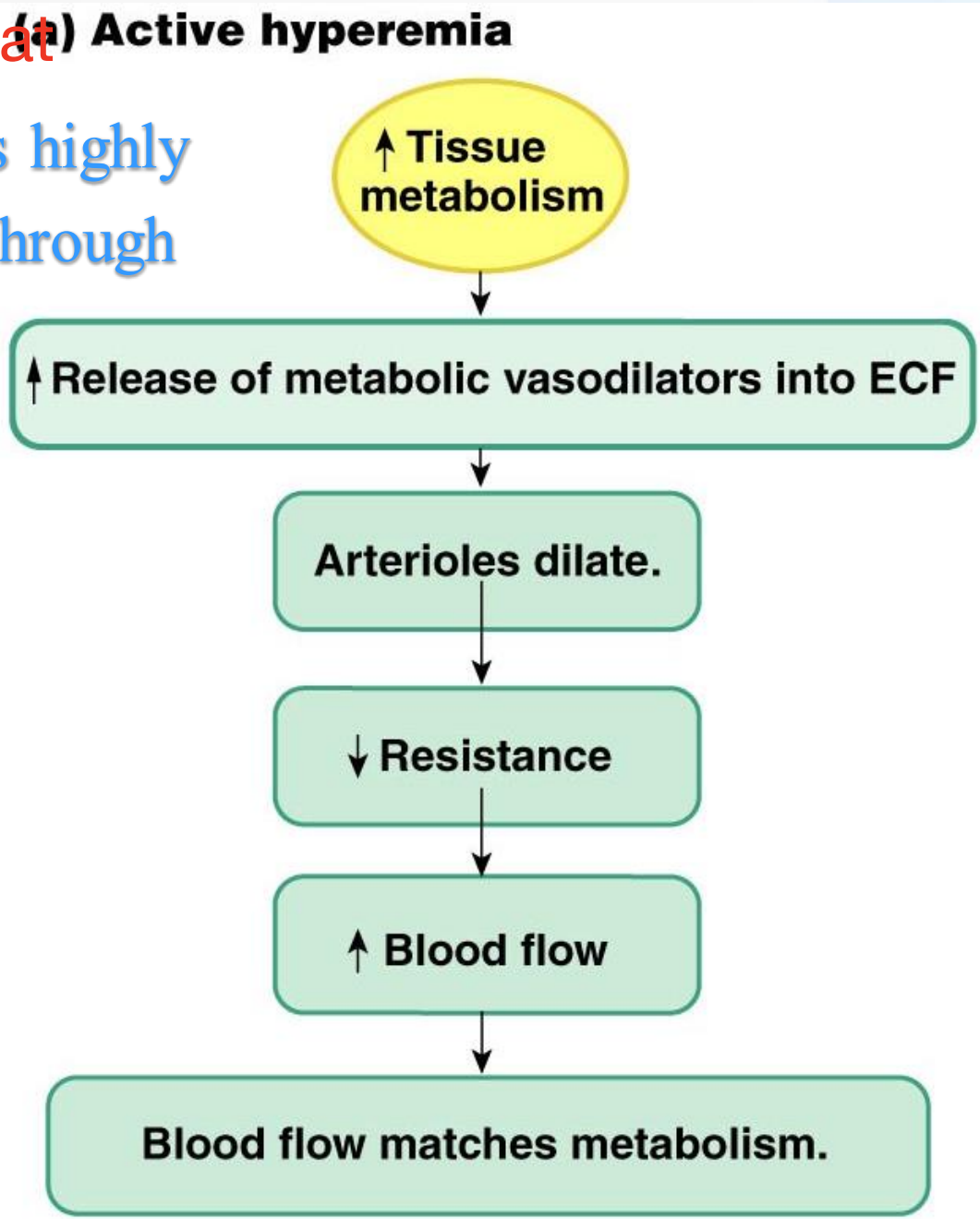
↓ " " → vasodilation

Active Hyperemia (Metabolic activity)

A metabolic activity relase metabolic product → vasodilat

- When a certain tissue becomes highly active, the rate of blood flow through the tissue increases.





End of lecture