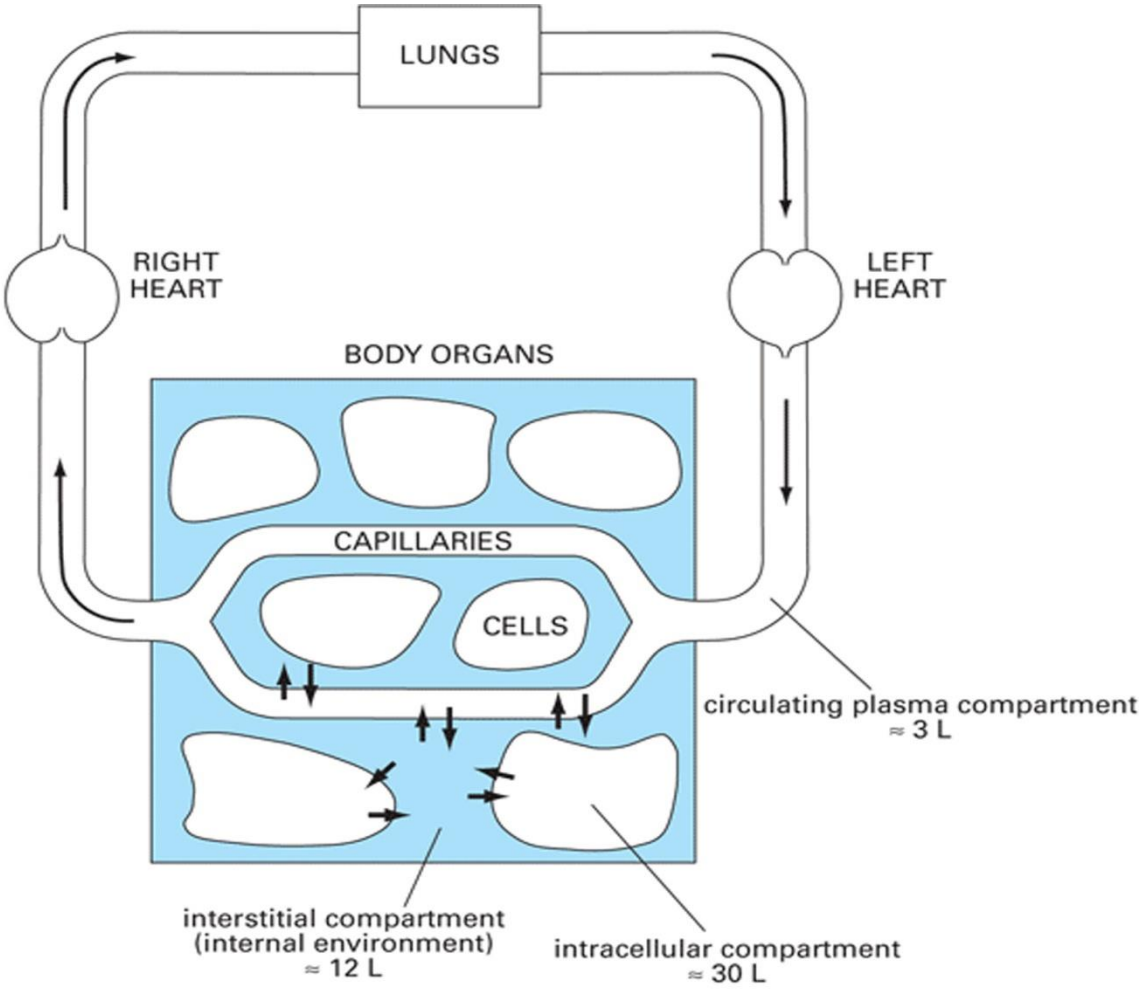
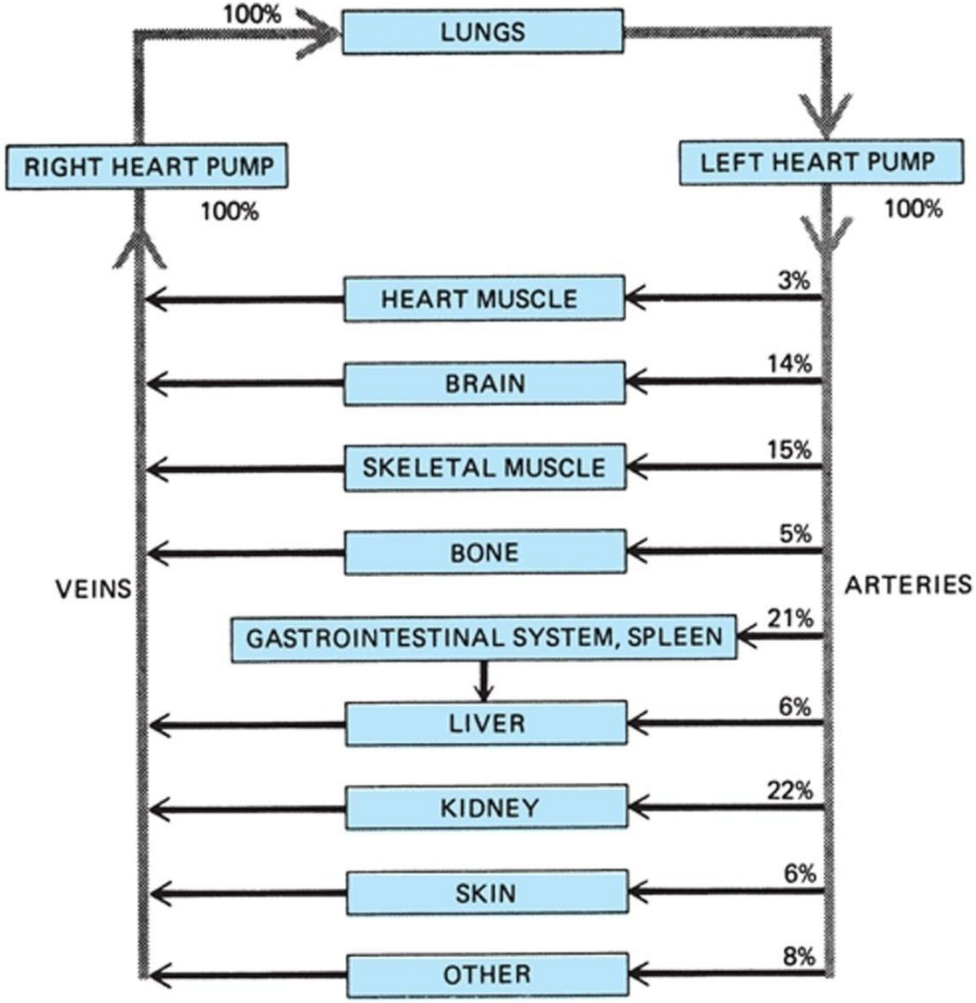
# CHAPTER ONE

## Homeostatic role of the cardiovascular system

# Major body fluid compartments with average volumes indicated for a 70-Kg human

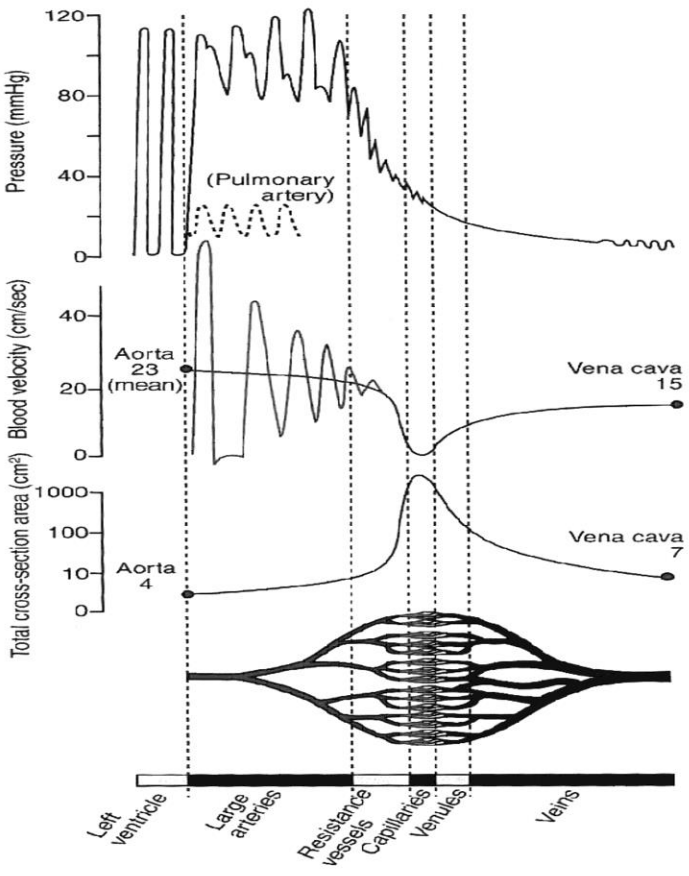


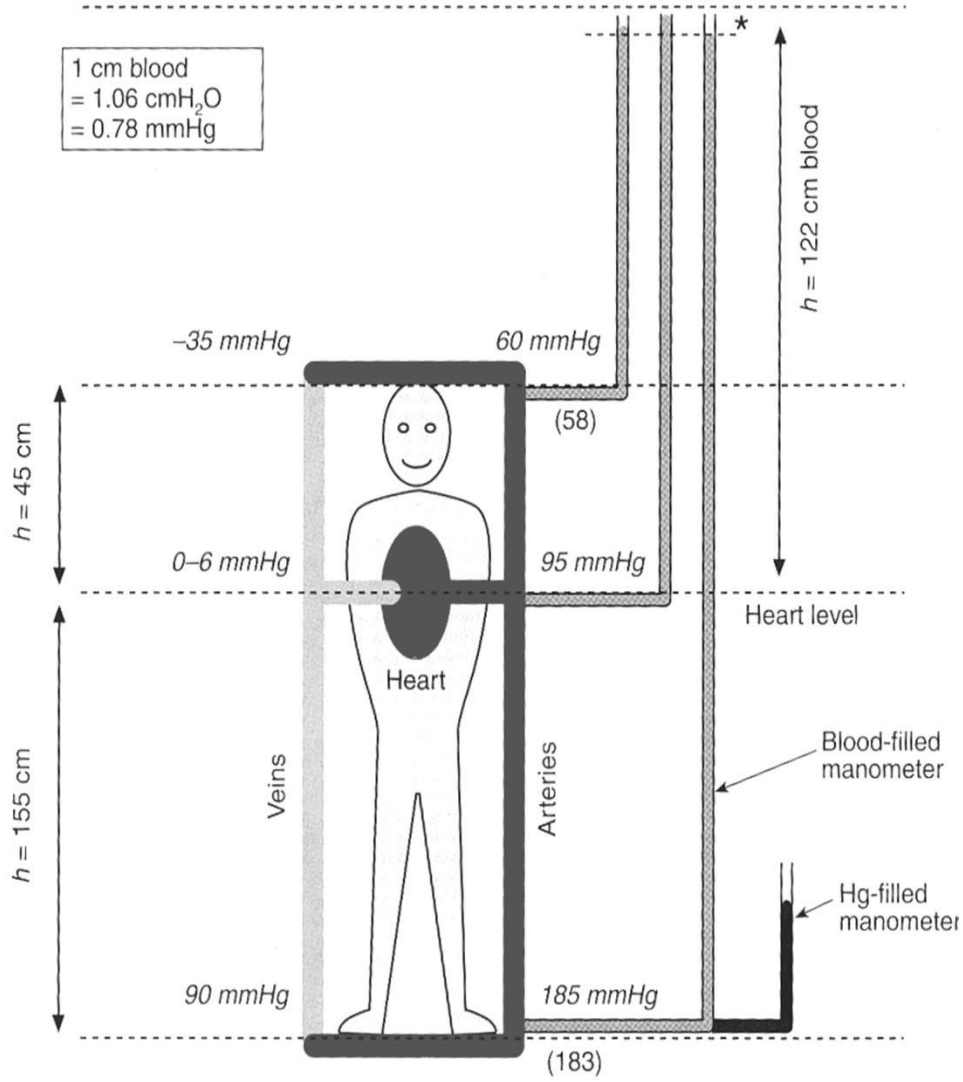
# Cardiovascular circuitry indicating the percentage distribution of cardiac output to various organ system in a resting individual



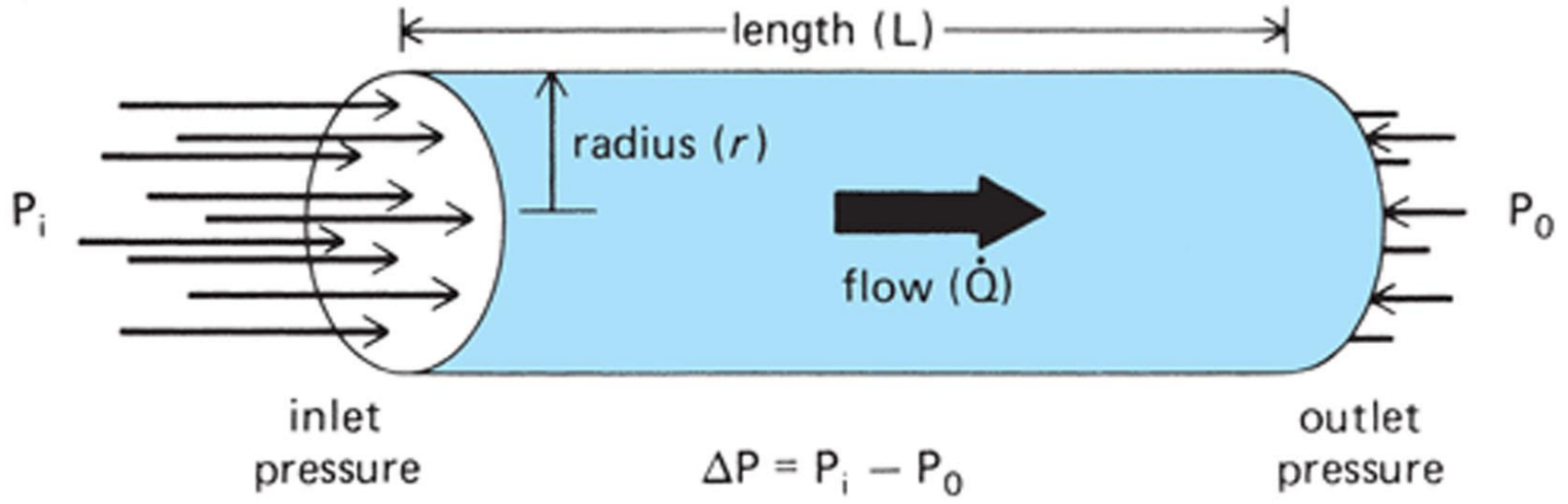
# *CHAPTER TWO*

## Hemodynamic

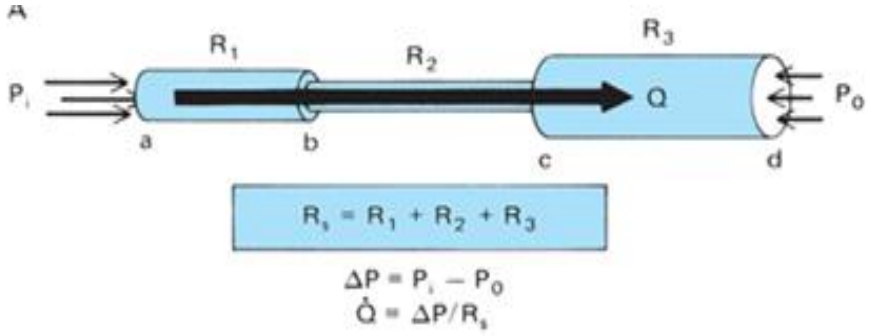

Pressure (mmHg)
120
80
40
0
(Pulmonary artery)
Blood velocity (cm/sec)
40
20
0
Aorta 23 (mean)
Vena cava 15
Total cross-section area (cm²)
1000
100
10
0
Aorta 4
Vena cava 7
Left ventricle
Large arteries
Resistance vessels
Capillaries
Venules
Veins

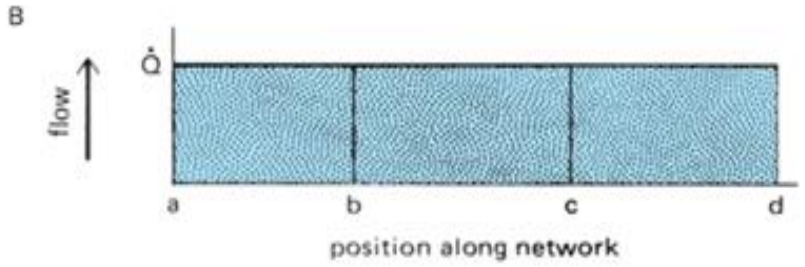

1 cm blood
= 1.06 cm$H_2O$
= 0.78 mmHg
*
h = 122 cm blood
–35 mmHg
60 mmHg
(58)
h = 45 cm
0–6 mmHg
95 mmHg
Heart level
Heart
Veins
Arteries
Blood-filled manometer
h = 155 cm
Hg-filled manometer
90 mmHg
185 mmHg
(183)

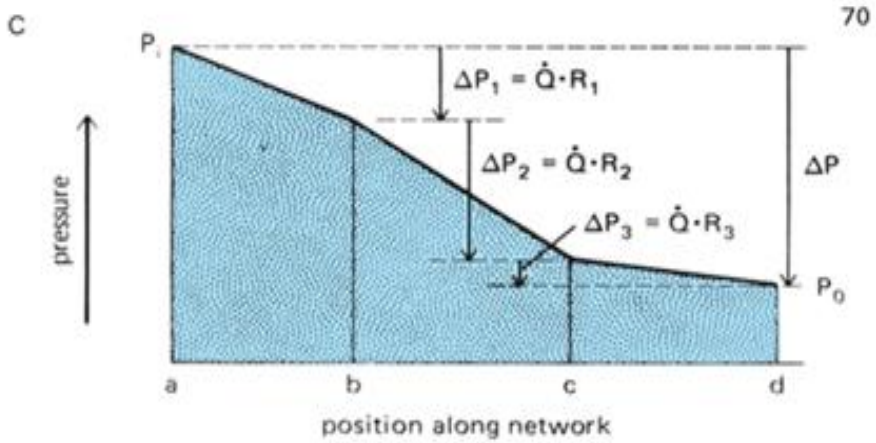
# Factors influencing fluid flow through a tube



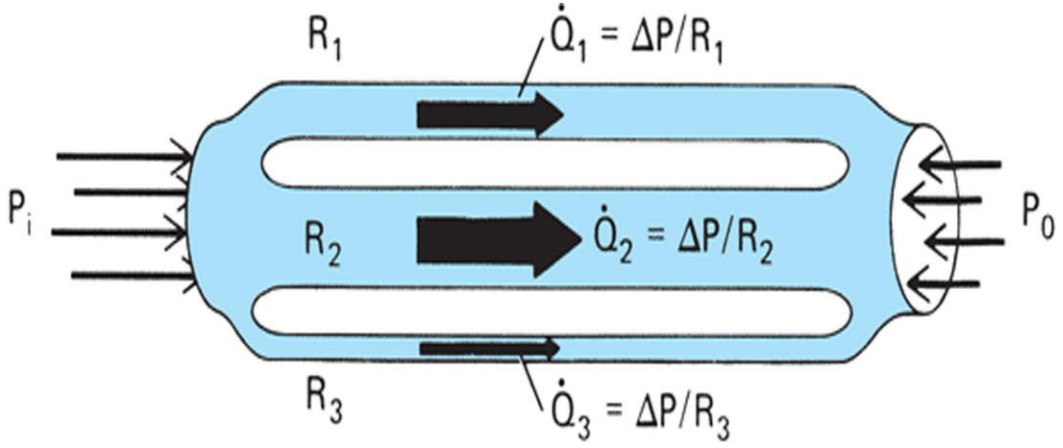
# Series resistance network



# Parallel resistance network



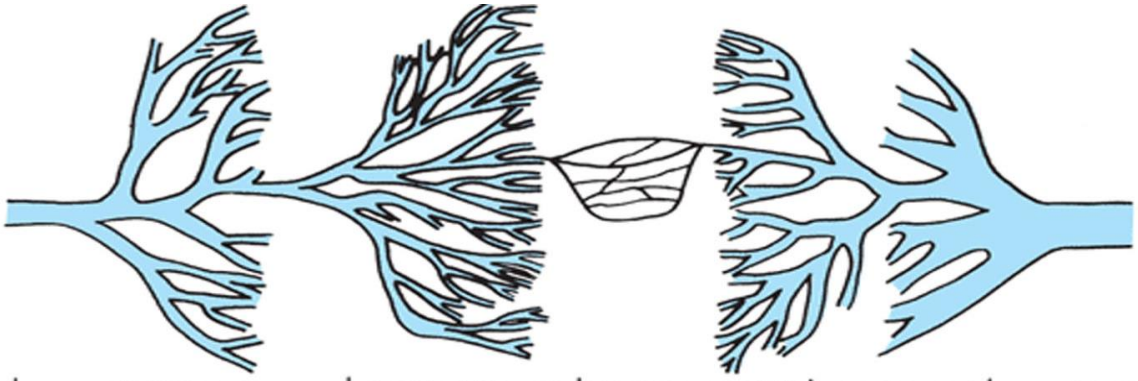

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\Delta P = P_i - P_0$$

$$\dot{Q}_{total} = \dot{Q}_1 + \dot{Q}_2 + \dot{Q}_3$$

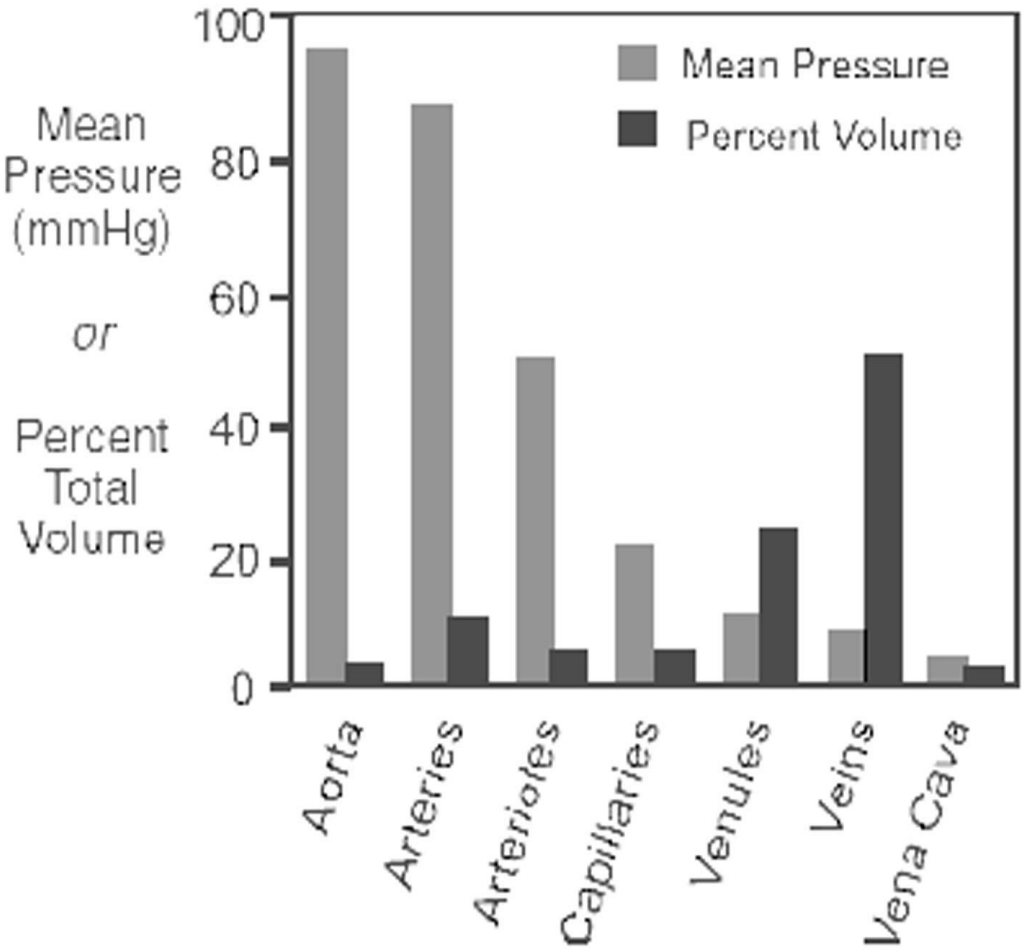
$$\dot{Q}_{total} = \Delta P / R_p$$

# Structural characteristics of the peripheral vascular system

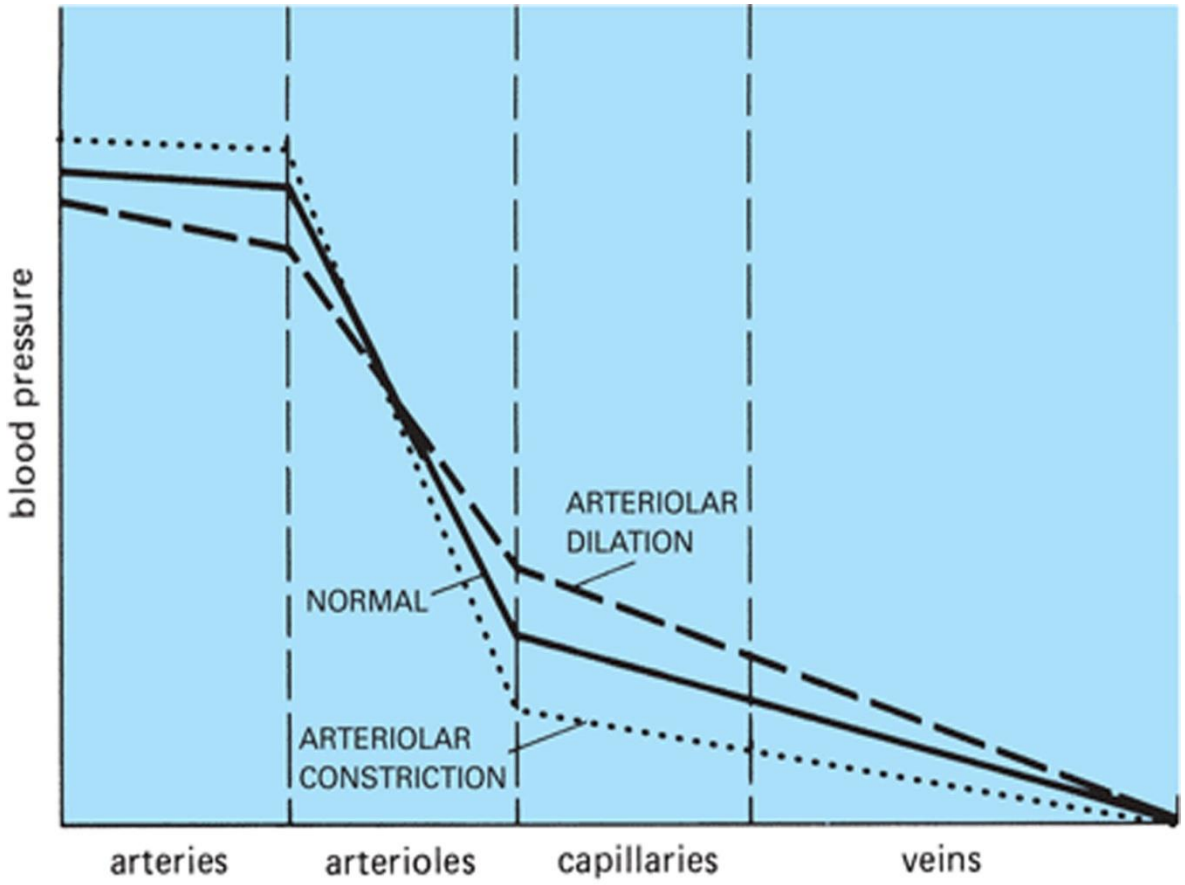


| | ARTERIES | | ARTERIOLES | CAPILLARIES | VENULES | VEINS | |
|---|---|---|---|---|---|---|---|
| | Aorta | | | | one-way valves | | Venae cavae |
| internal diameter | 2.5 cm | 0.4 cm | 30 $\mu$m | 5$\mu$m | 70 $\mu$m | 0.5 cm | 3 cm |
| wall thickness | 2 mm | 1 mm | 20 $\mu$m | 1 $\mu$m | 7$\mu$m | 0.5 mm | 1.5 mm |
| number | 1 | 160 | $5 \times 10^7$ | $10^{10}$ | $10^8$ | 200 | 2 |
| total cross-sectional area | 4.5 $cm^2$ | 20 $cm^2$ | 400 $cm^2$ | 4500 $cm^2$ | 4000 $cm^2$ | 40 $cm^2$ | 18 $cm^2$ |

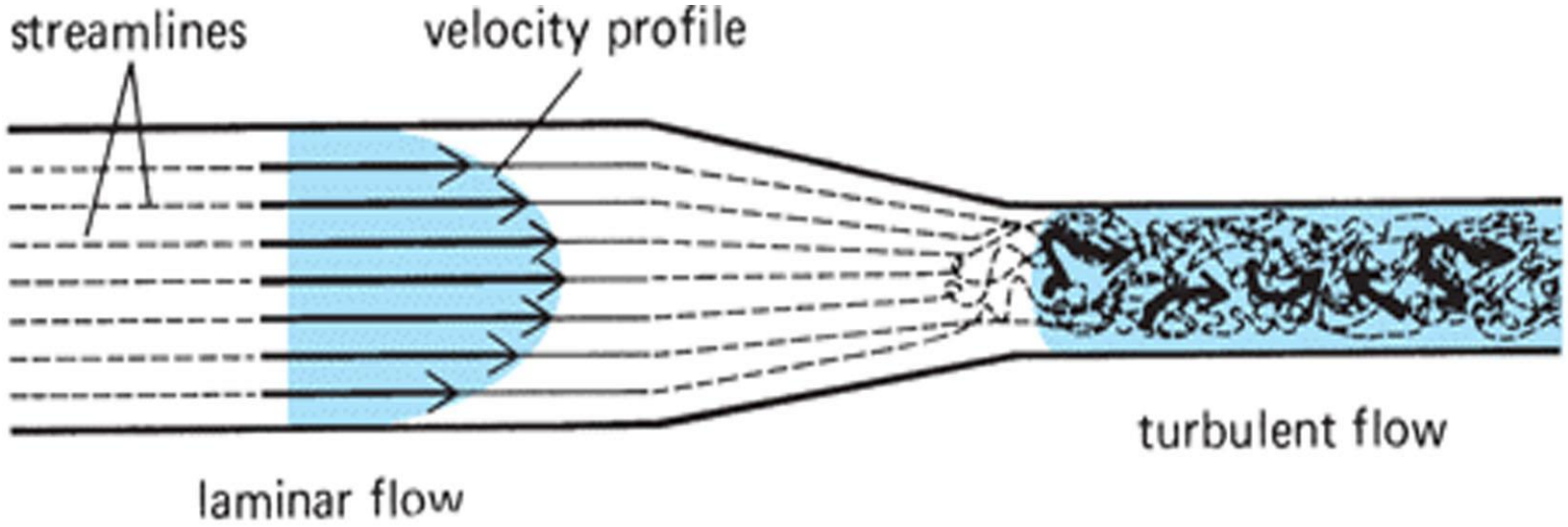
# Mean blood pressure & percent total volume



# Effect of changes resistance on vascular pressures



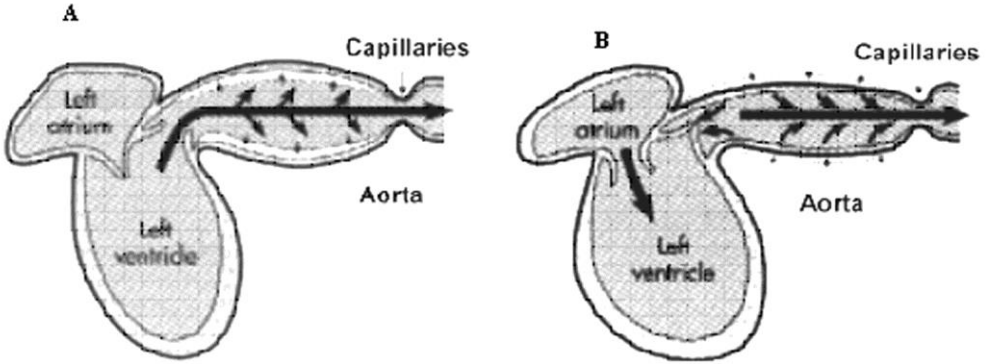
# Laminar & turbulent flow patterns



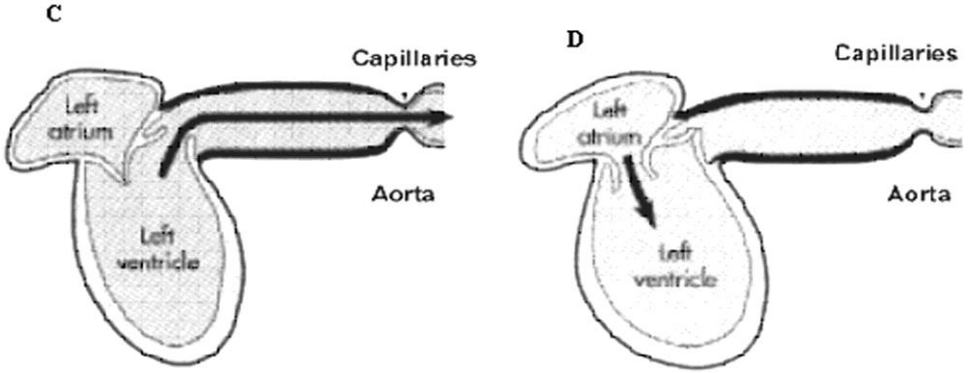
# CHAPTER THREE

## Physiological roles of arteries

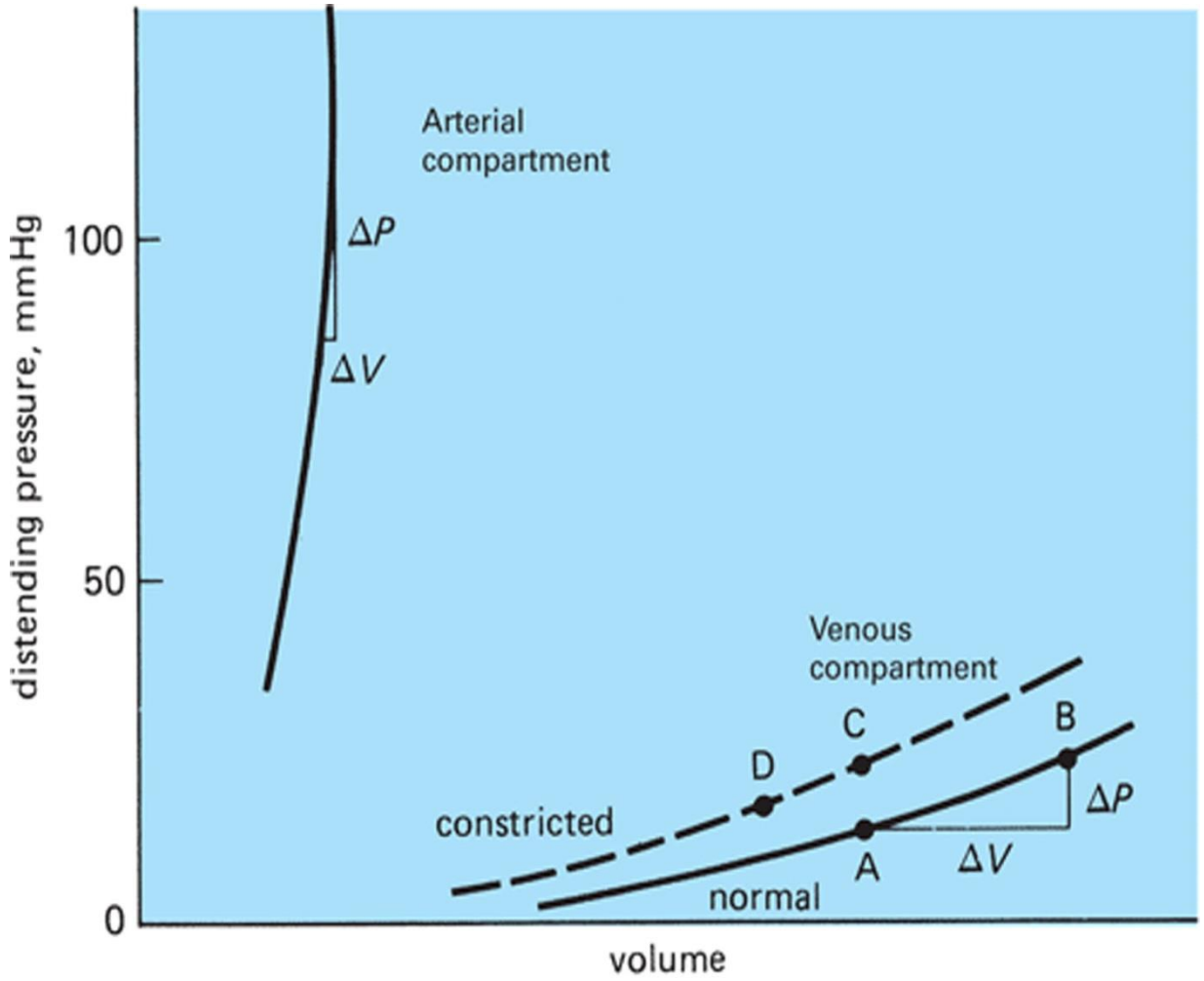
**Elastic arteries**



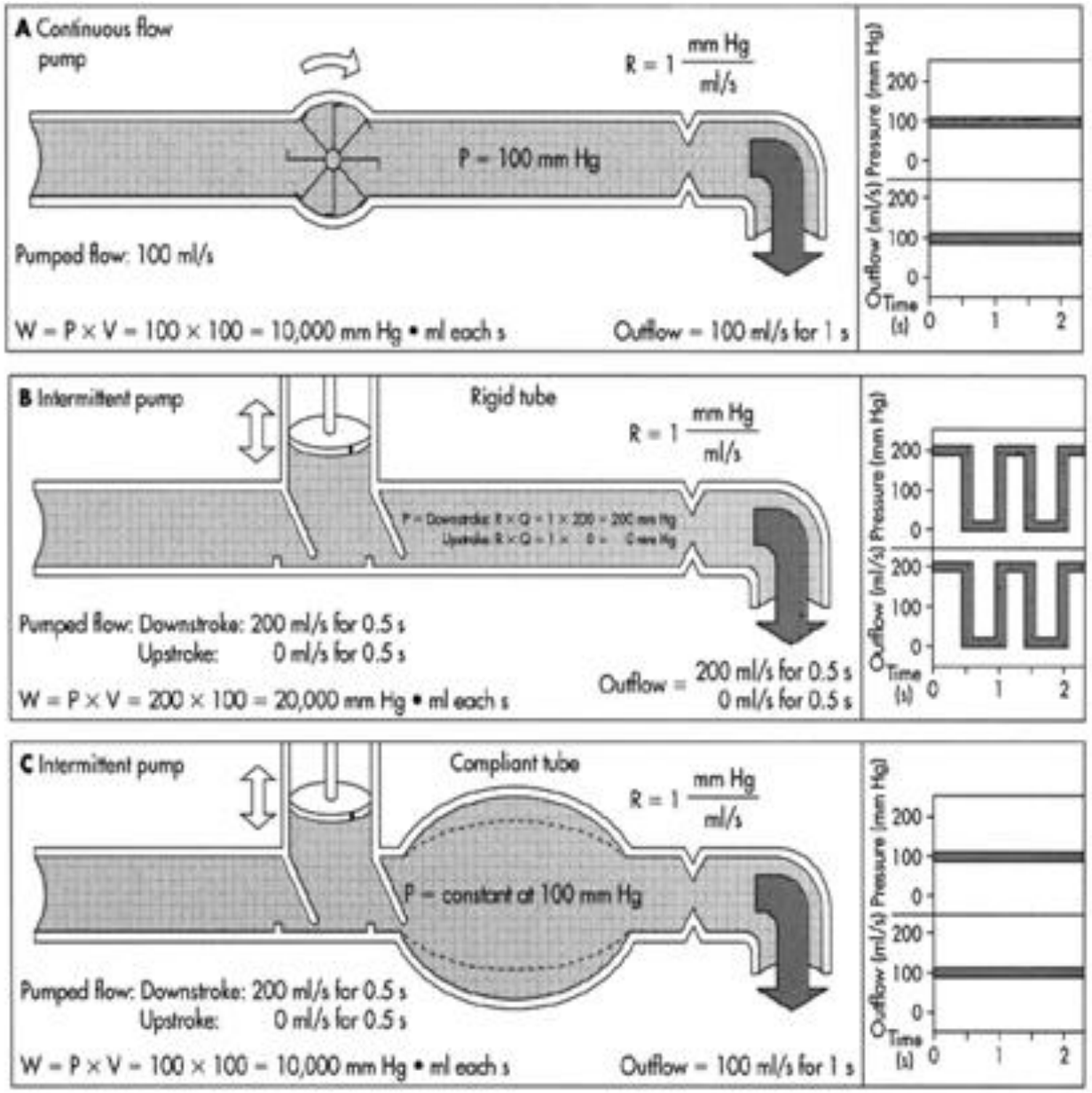

**Rigid arteries**



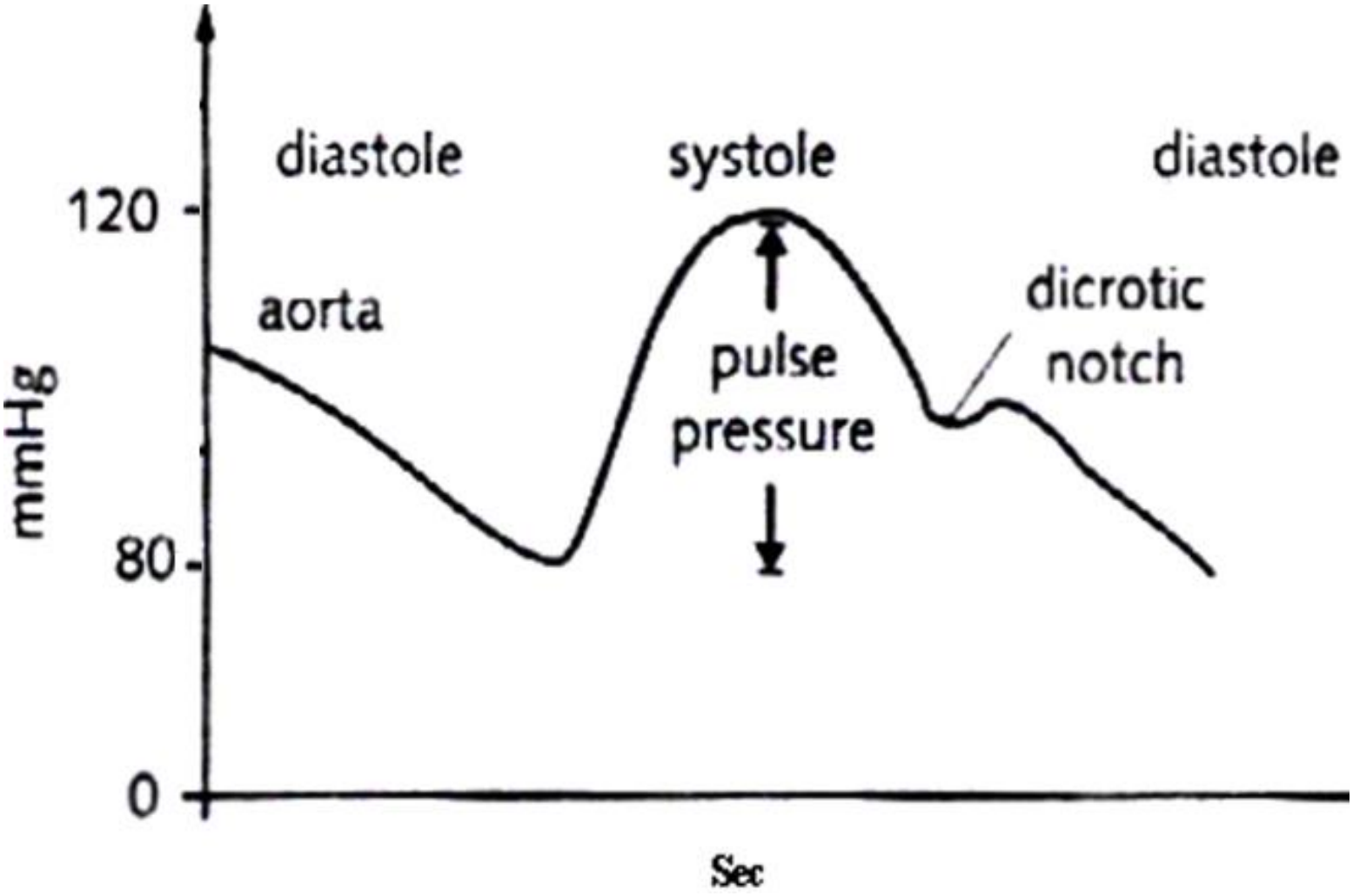
# Volume-pressure curves of arterial and venous compartments



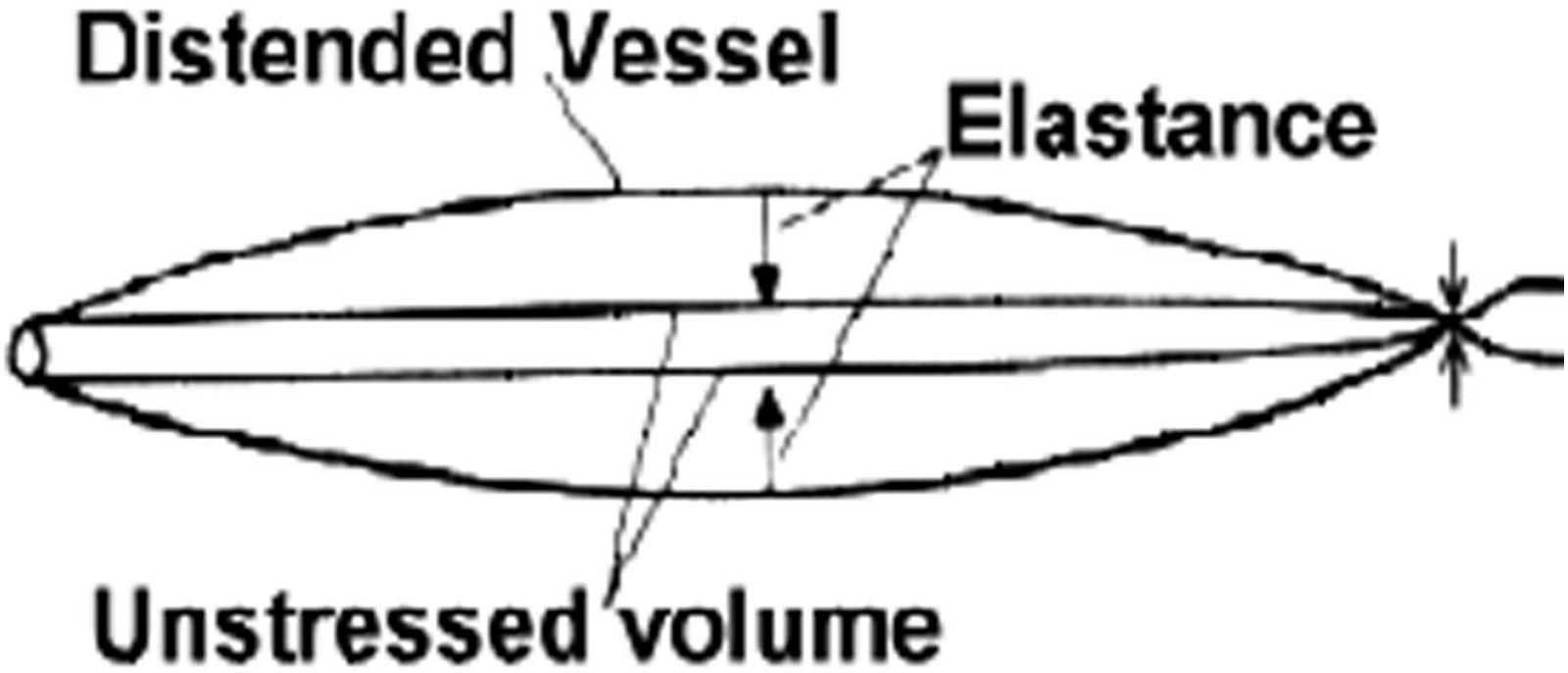
# Cardiac work



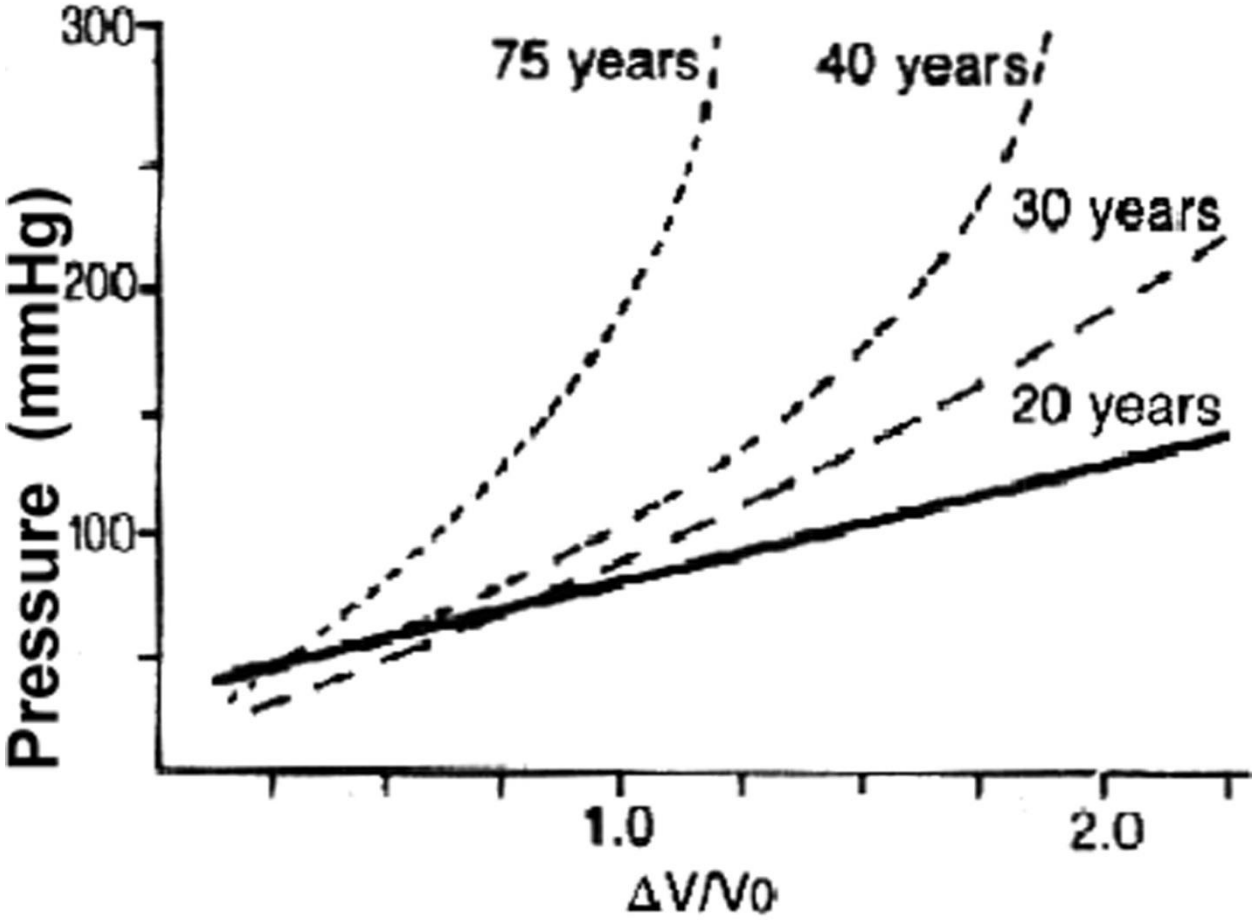
# Mean blood pressure



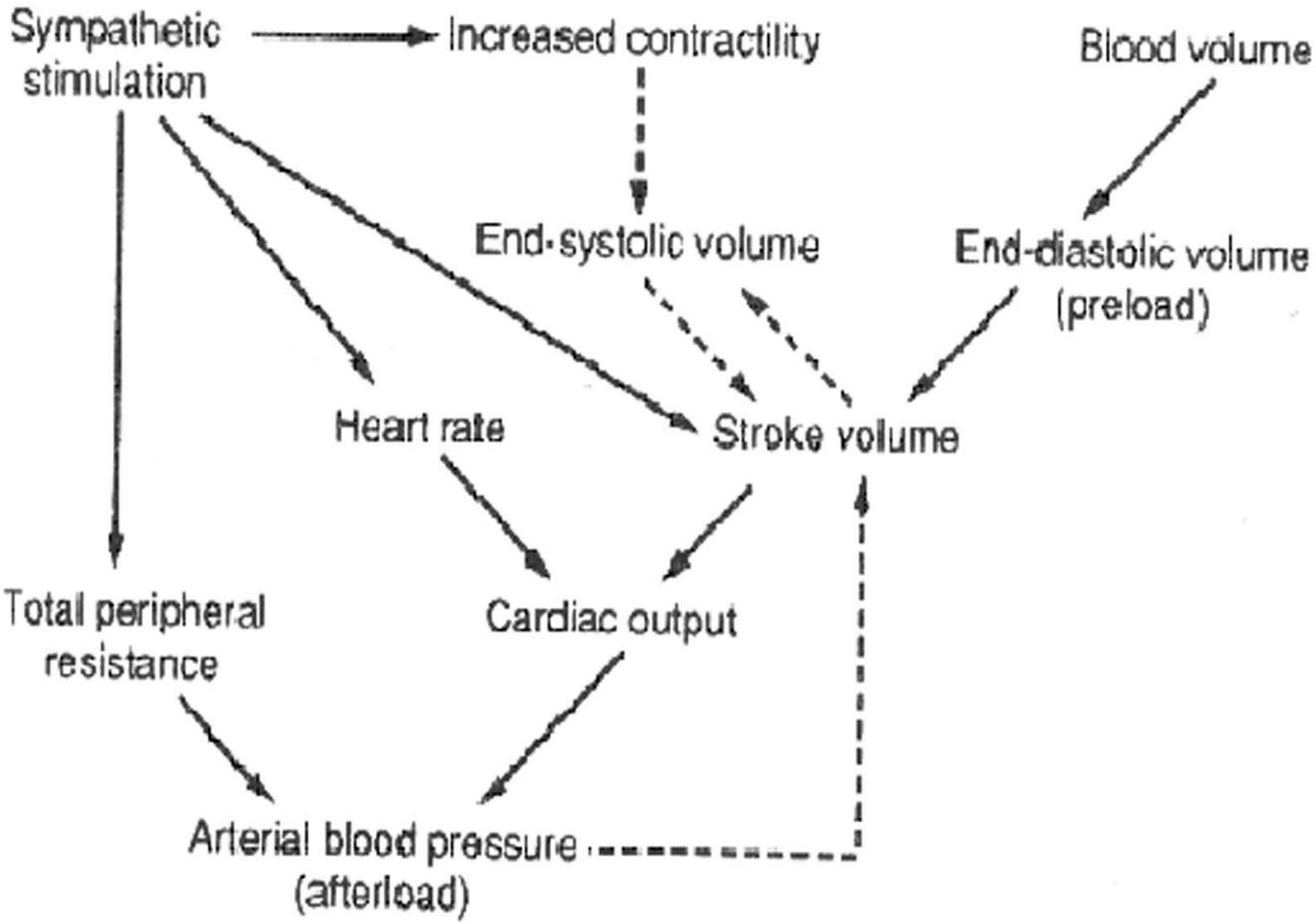
# Arterial elasticity



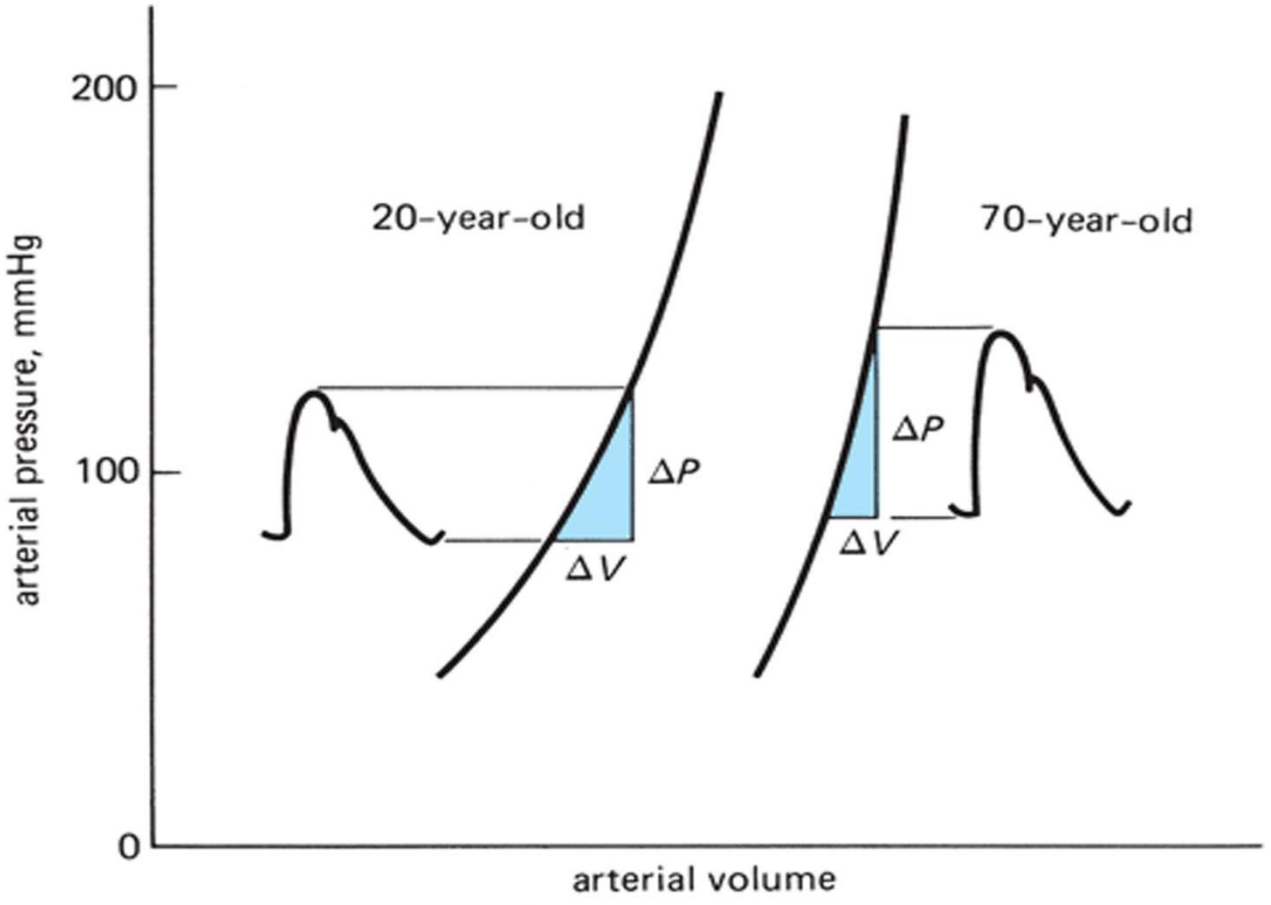
# Elasticity & aging



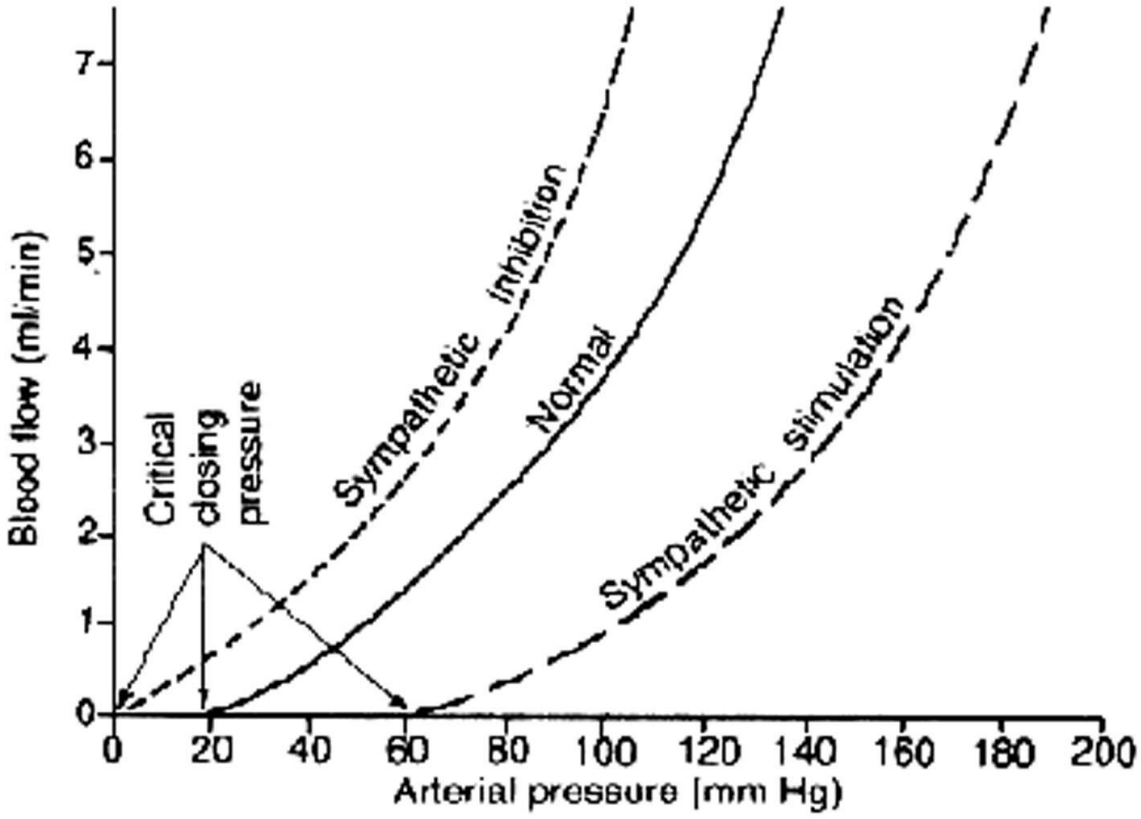
# Factors influencing arterial blood pressure



# Effects of age on the systemic arterial volume-pressure relationship



# Blood flow, arterial pressure & resistance relationship

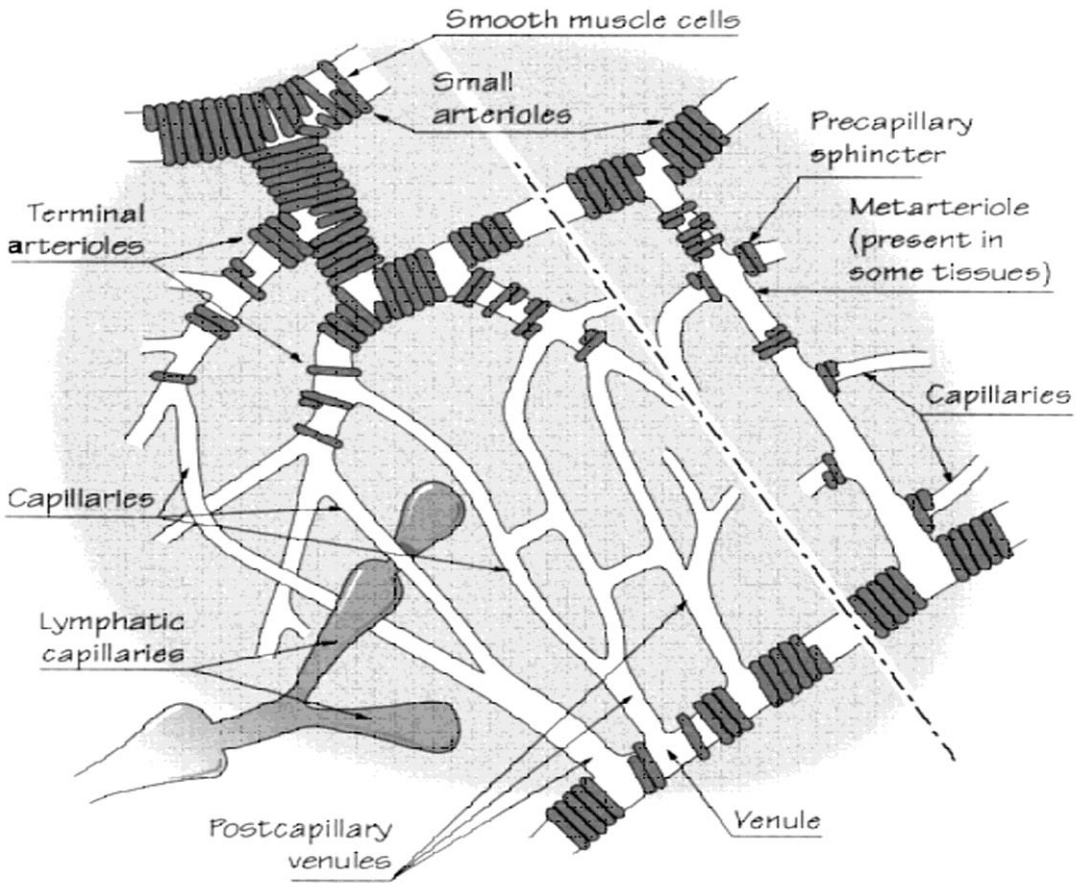


# *CHAPTER FOUR*

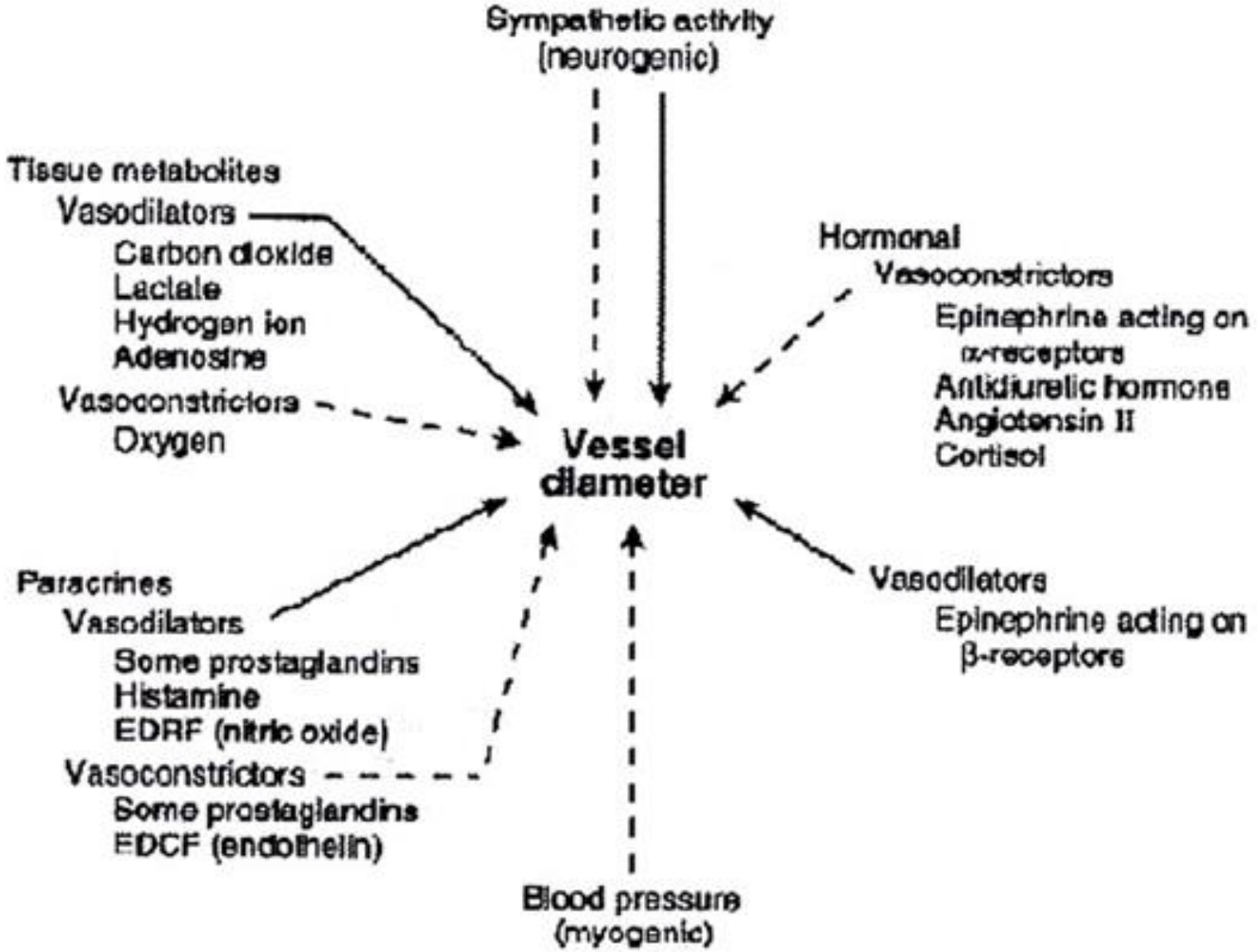
## Microcirculation

| ORGAN | PERCENT BODY WEIGHT | PERCENT CARDIAC OUTPUT AT REST | NORMAL FLOW (ML/MIN PER 100 G) | MAXIMAL FLOW (ML/MIN PER 100 G) |
|---|---|---|---|---|
| Heart | 0.4 | 5 | 80 | 400 |
| Brain | 2 | 14 | 55 | 150 |
| Skeletal muscle | 40 | 18 | 3 | 60 |
| Skin | 3 | 4 | 10 | 150 |
| Stomach, intestine, liver, spleen, pancreas | 6 | 23 | 30 | 250 |
| Kidneys | 0.4 | 20 | 400 | 600 |
| Other | 48 | 16 | - | - |

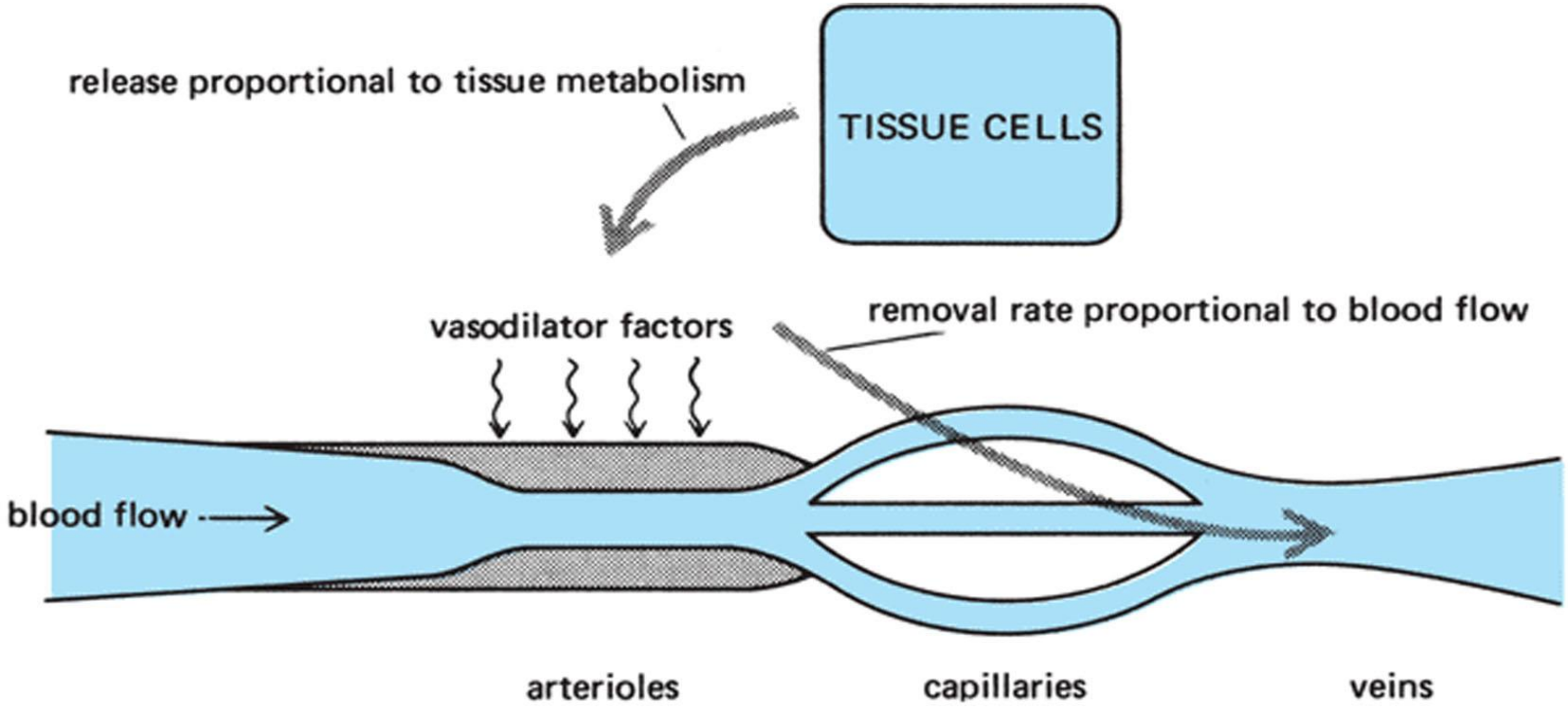
**Structure of the microcirculation**



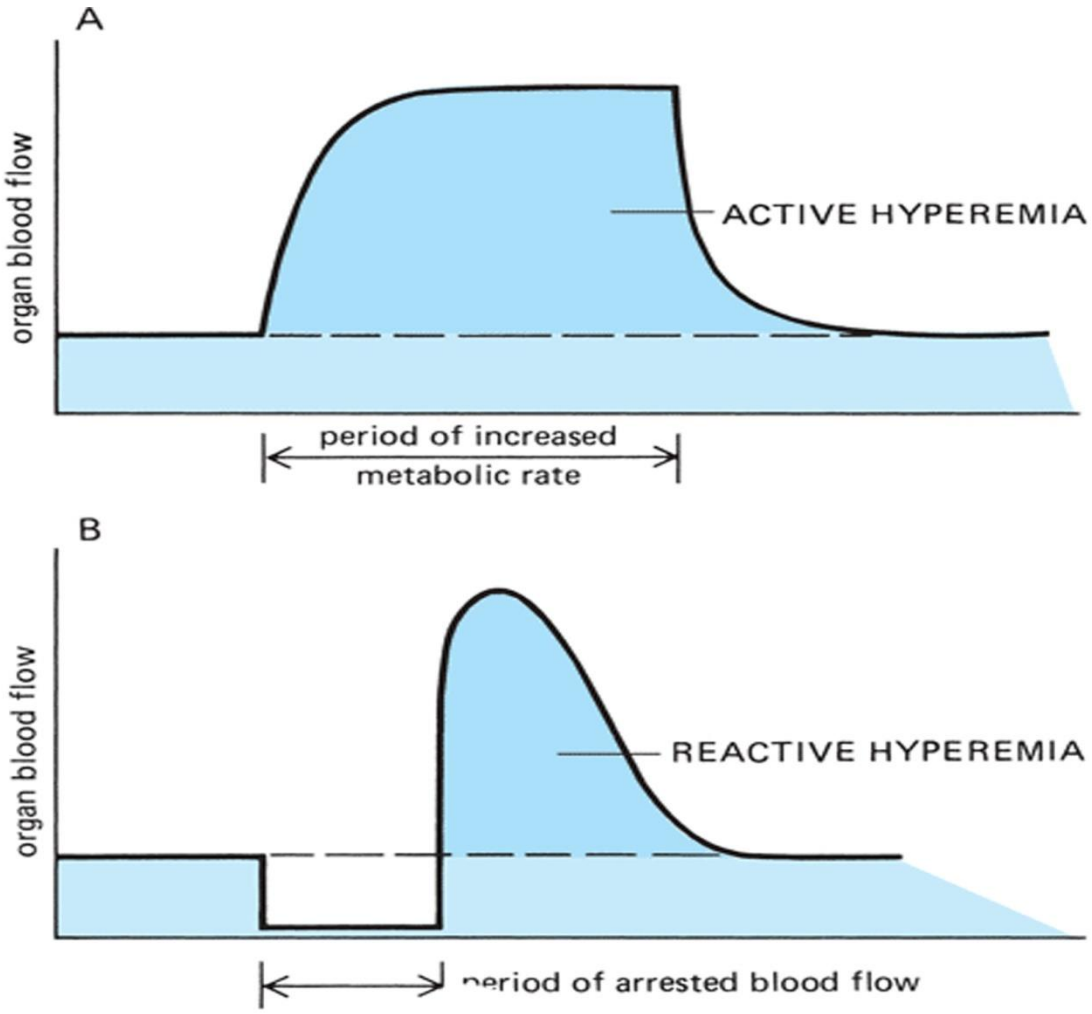
# Factors influencing vessel diameter



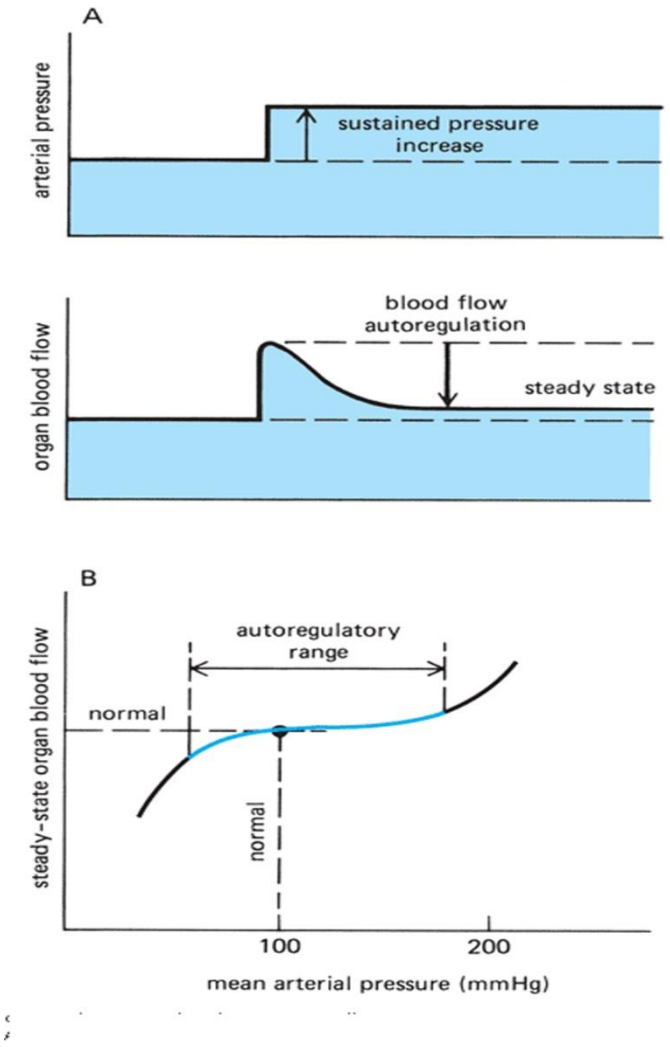
# Local metabolic vasodilator hypothesis



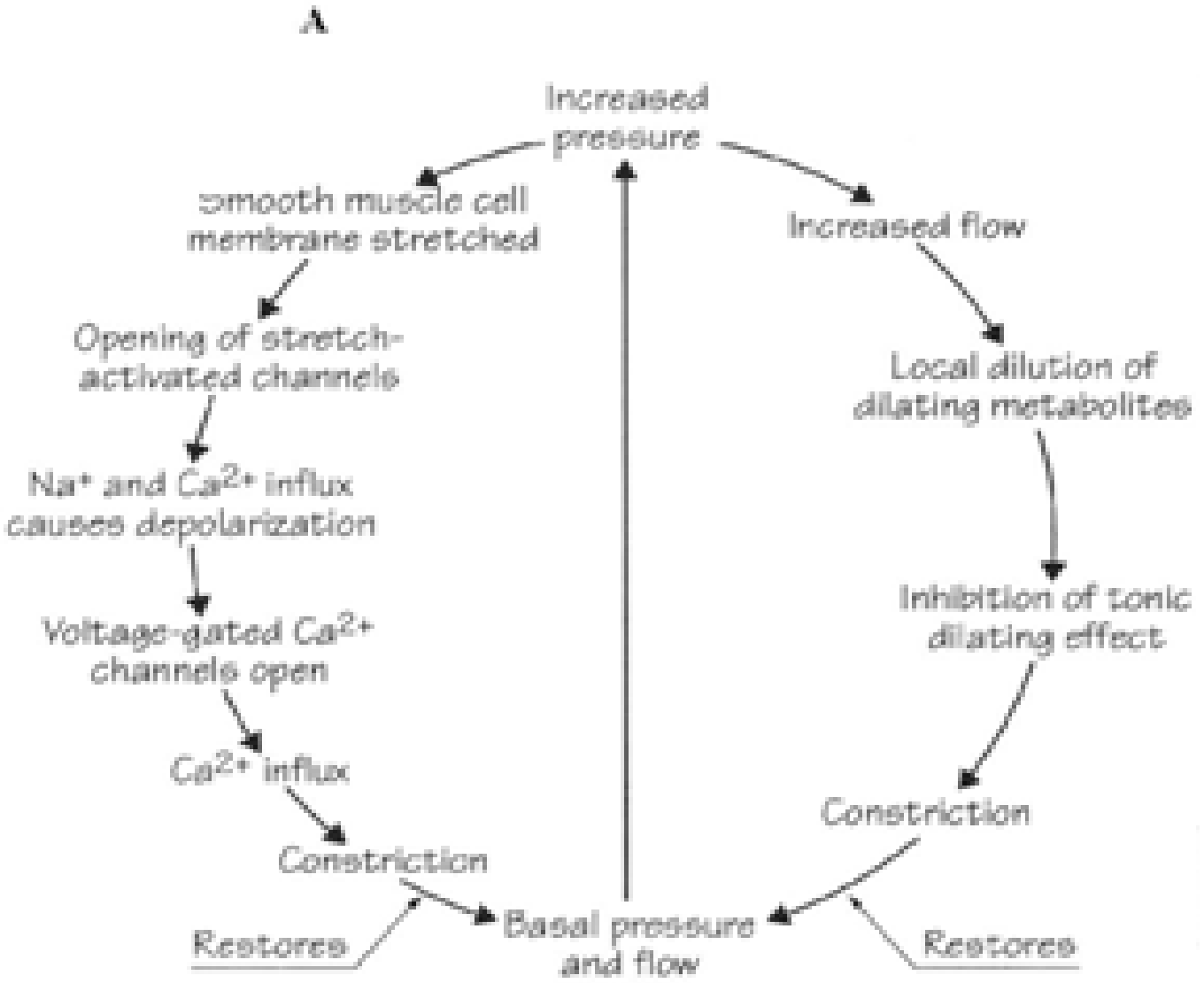
# Organ blood flow responses caused by local mechanism: active & reactive hyperemia

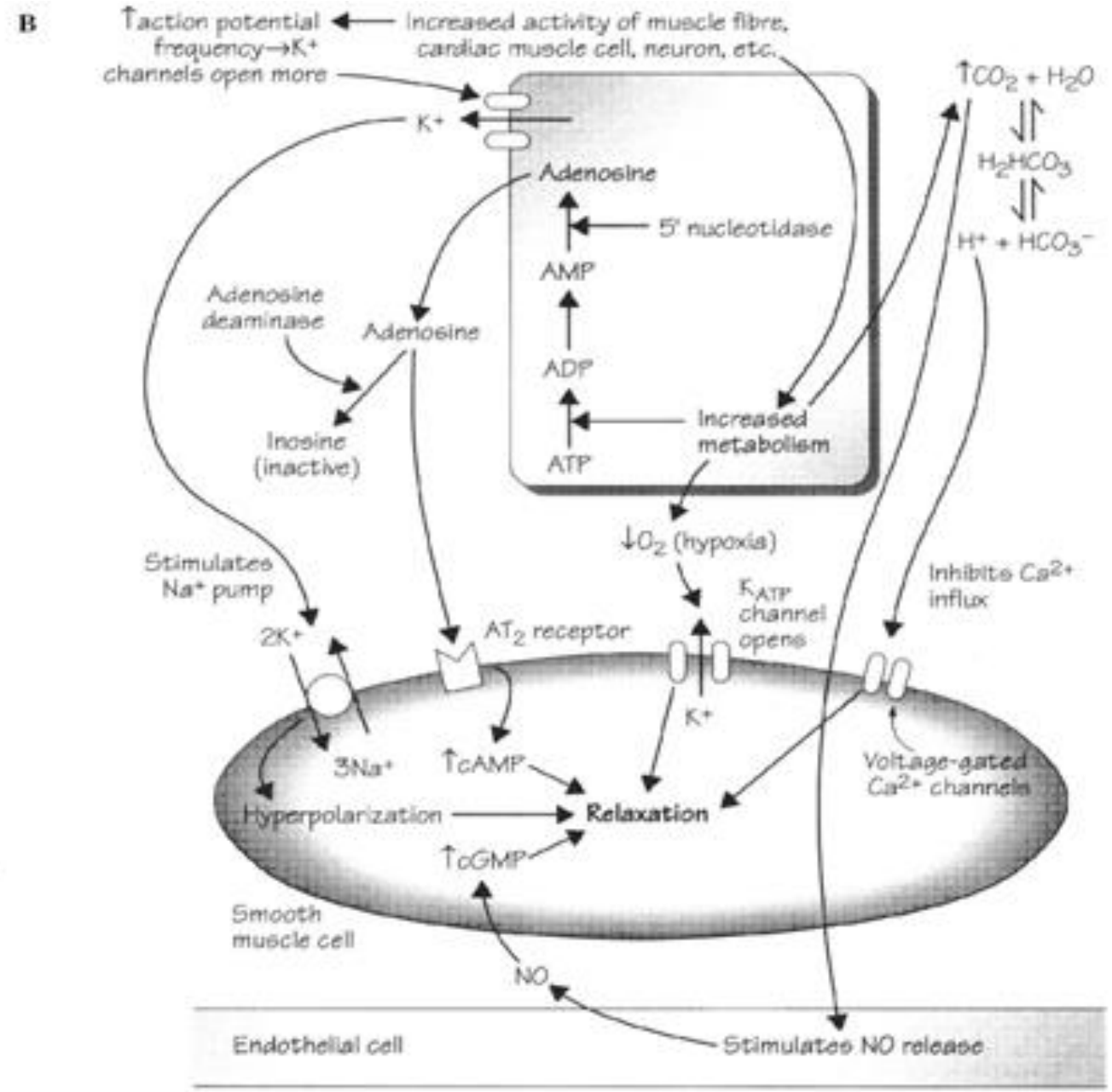


# Auto-regulation & cellular mechanisms of local regulation

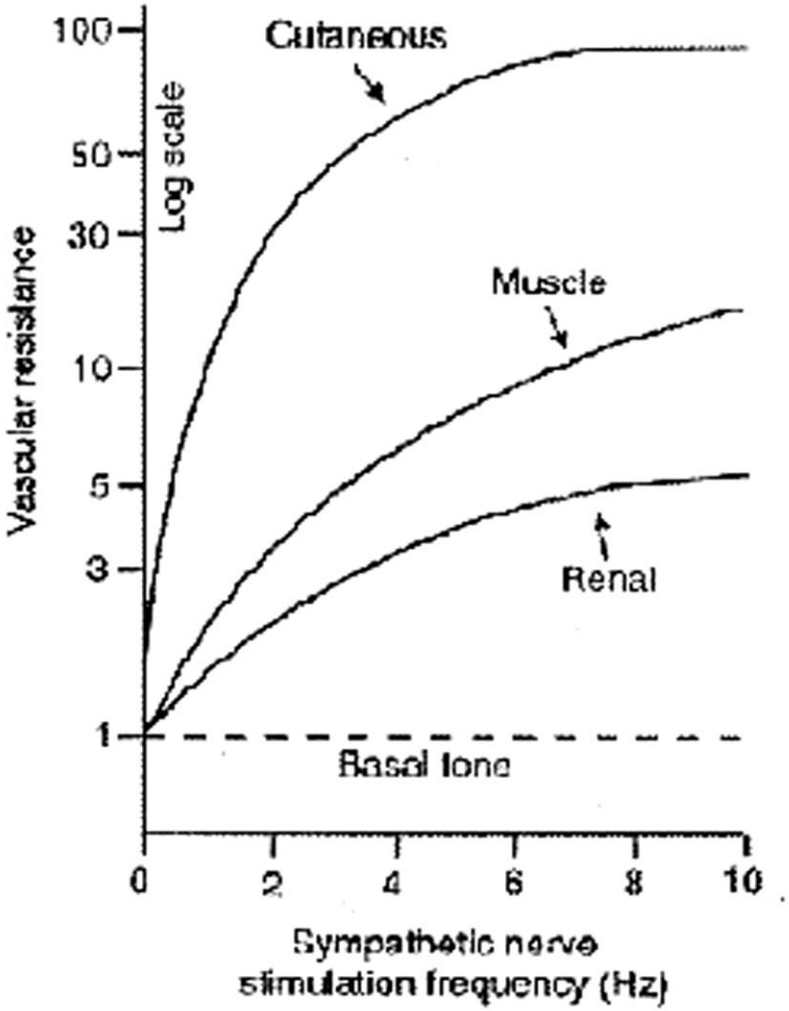


# Auto-regulation mechanism

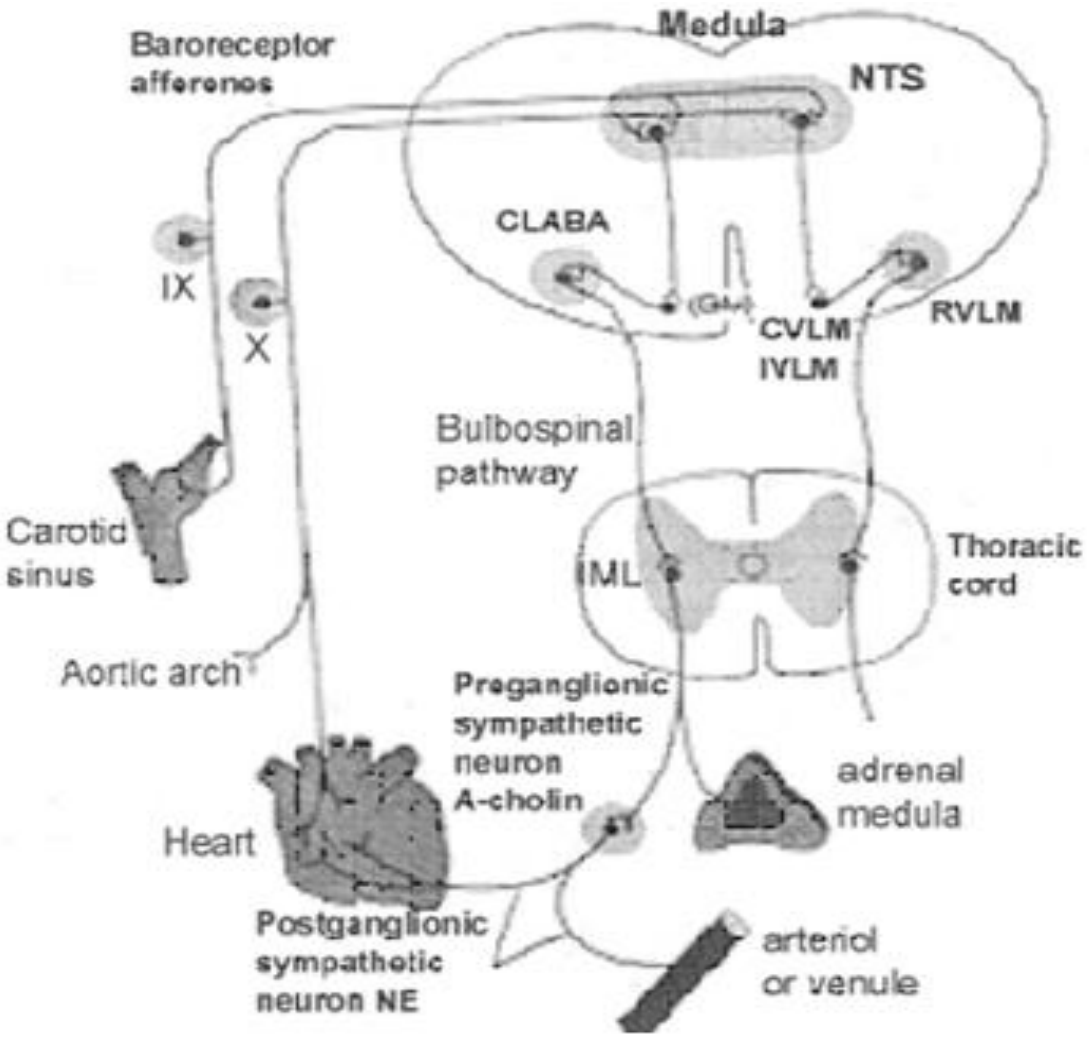



B
↑action potential frequency→K+ channels open more
Increased activity of muscle fibre, cardiac muscle cell, neuron, etc.
↑CO2 + H2O
H2HCO3
H+ + HCO3−
K+
Adenosine
5' nucleotidase
AMP
Adenosine deaminase
Adenosine
ADP
Inosine (inactive)
Increased metabolism
ATP
↓O2 (hypoxia)
Stimulates Na+ pump
KATP channel opens
Inhibits Ca2+ influx
2K+
AT2 receptor
K+
3Na+
↑cAMP
Voltage-gated Ca2+ channels
Hyperpolarization
Relaxation
↑cGMP
Smooth muscle cell
NO
Endothelial cell
Stimulates NO release

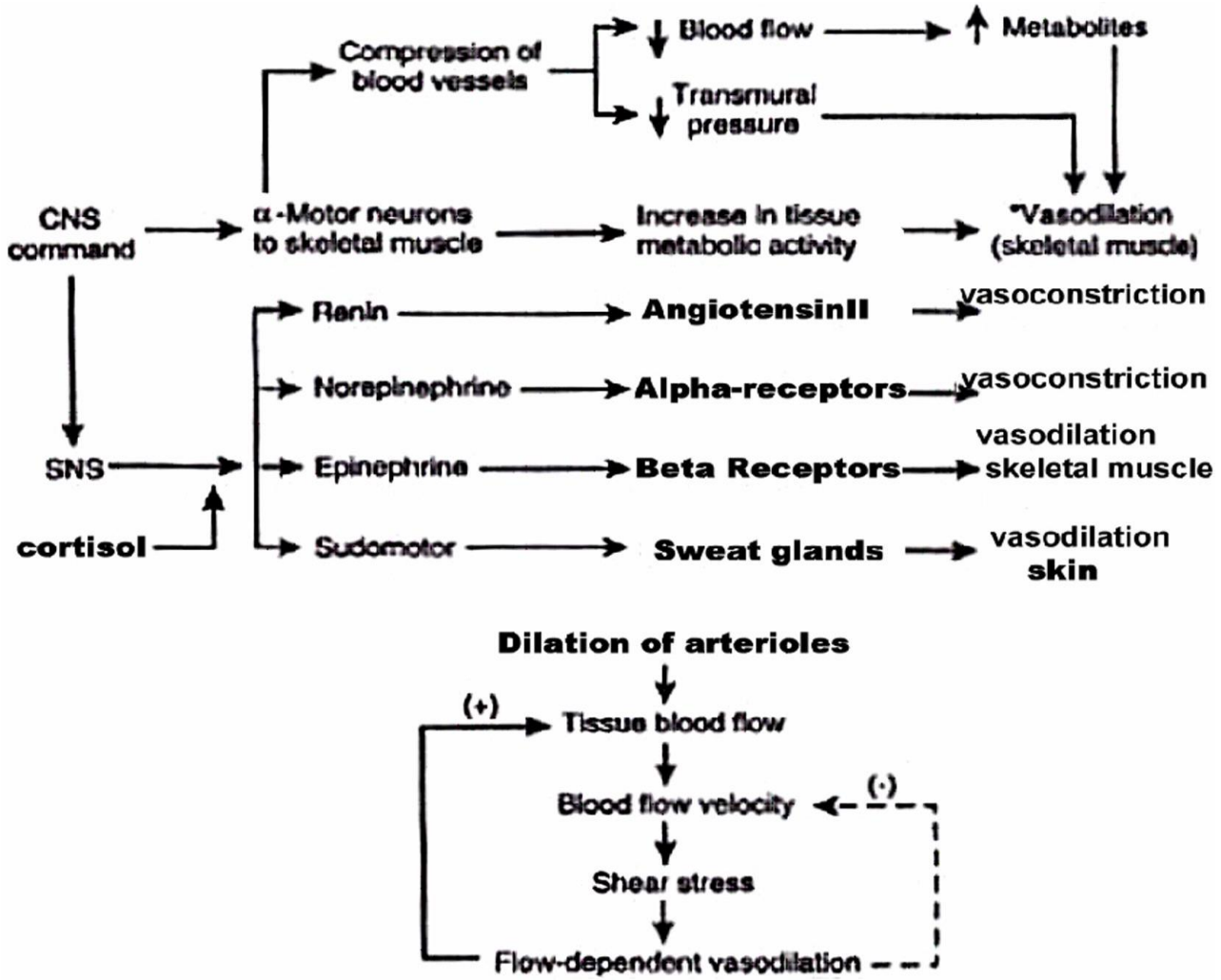
# General regulation: sympathetic nerve system



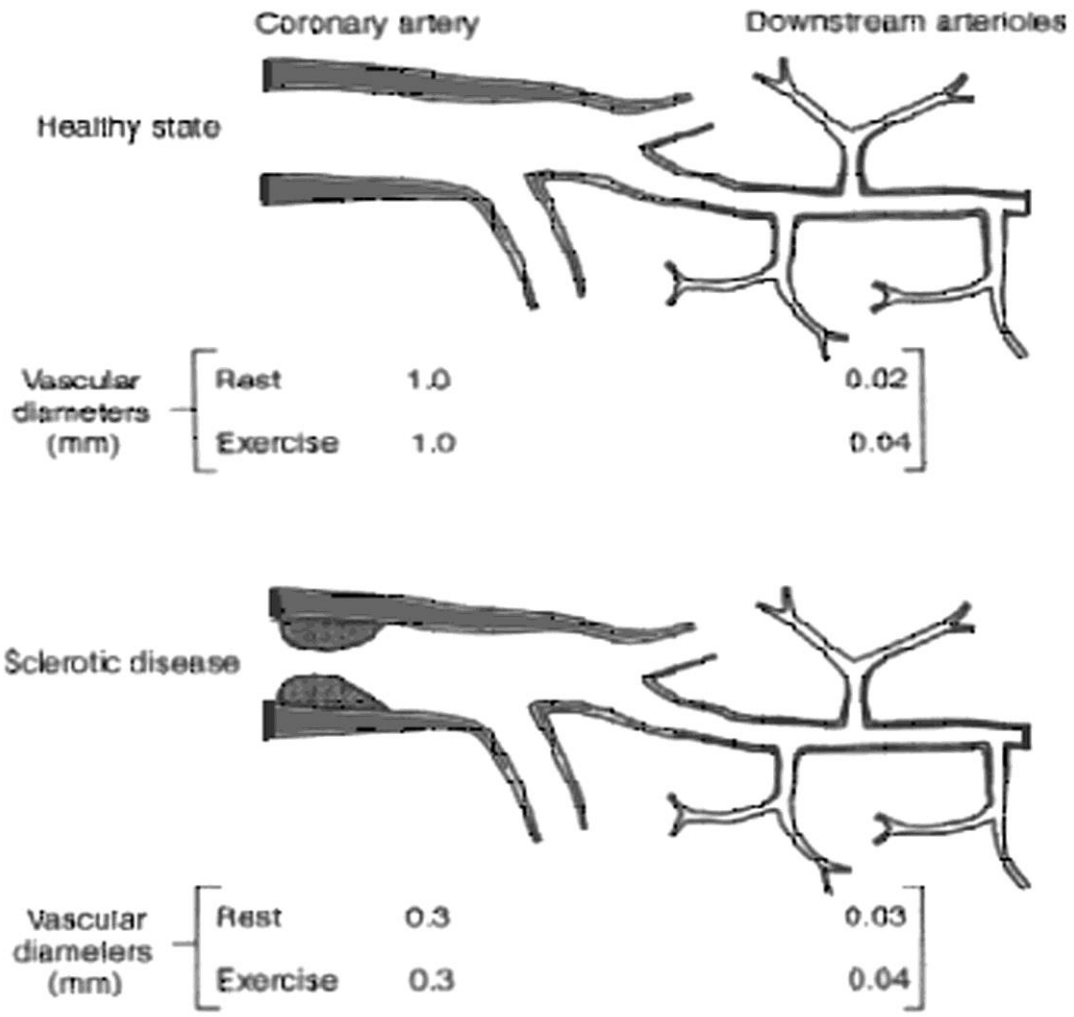
# Vasomotor center



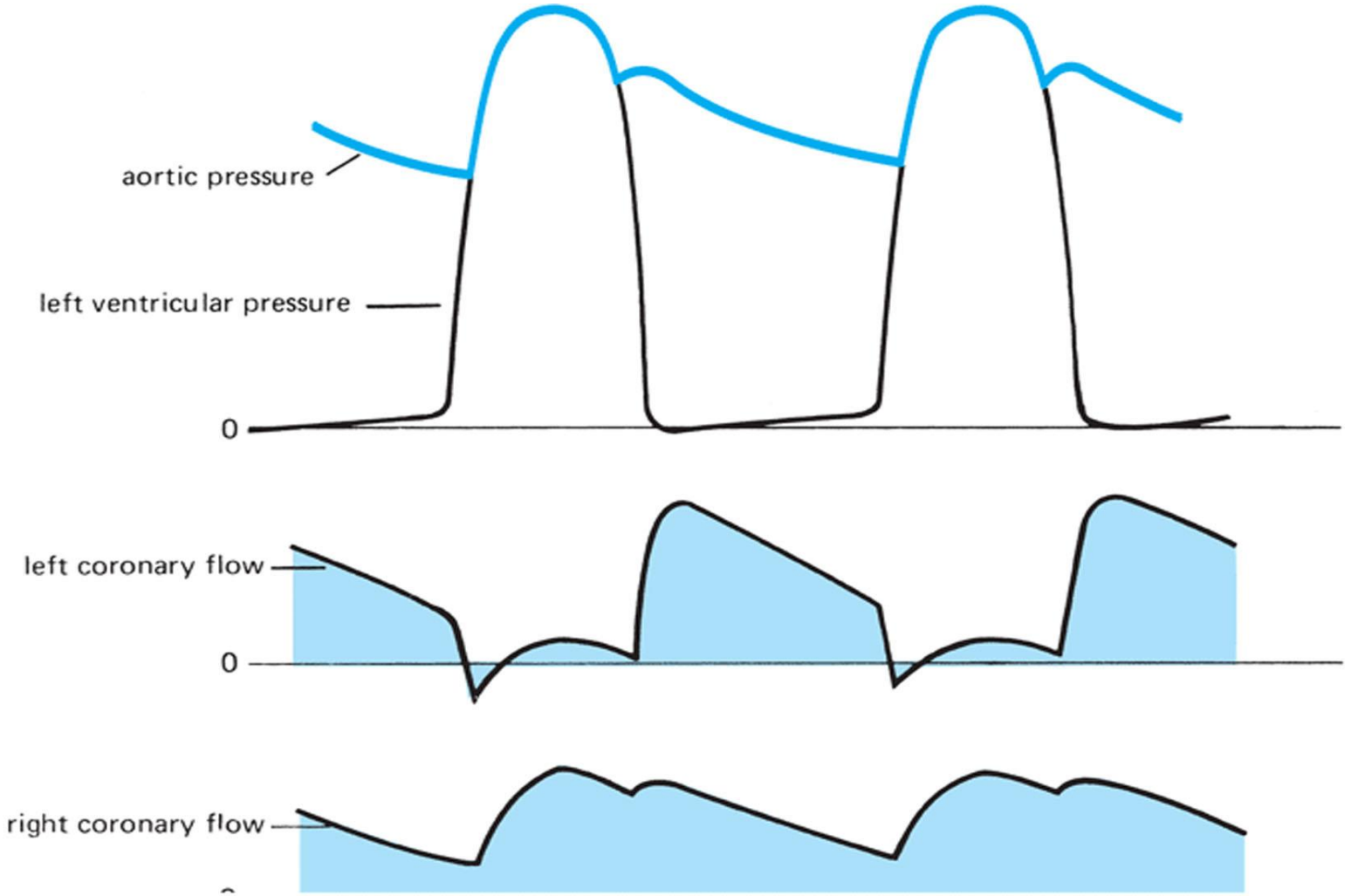
# Interaction of local and general regulation



# Coronary blood flow & aging



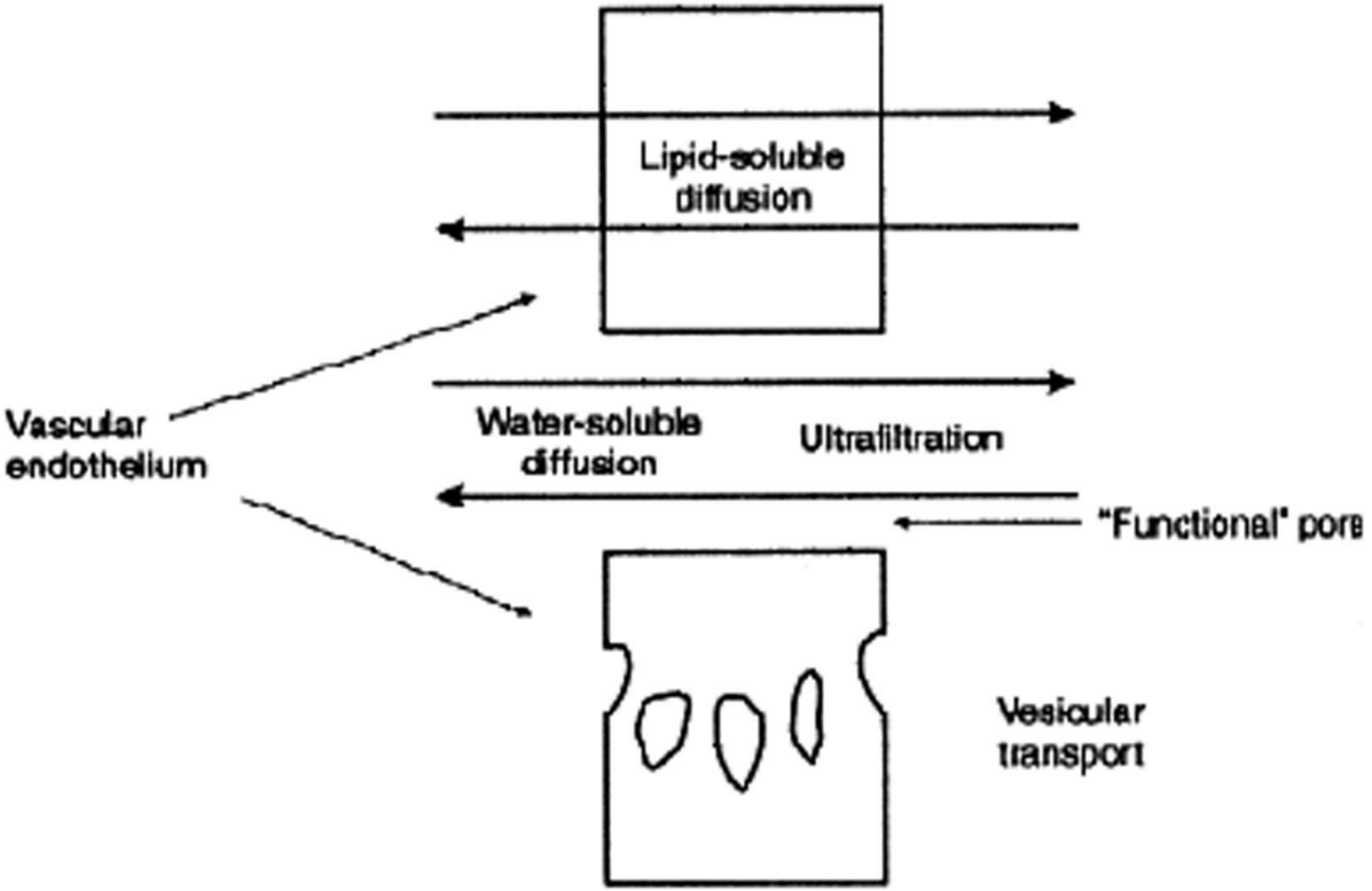
# Phasic flows in the left & right arteries in relation to aortic and left ventricular pressures



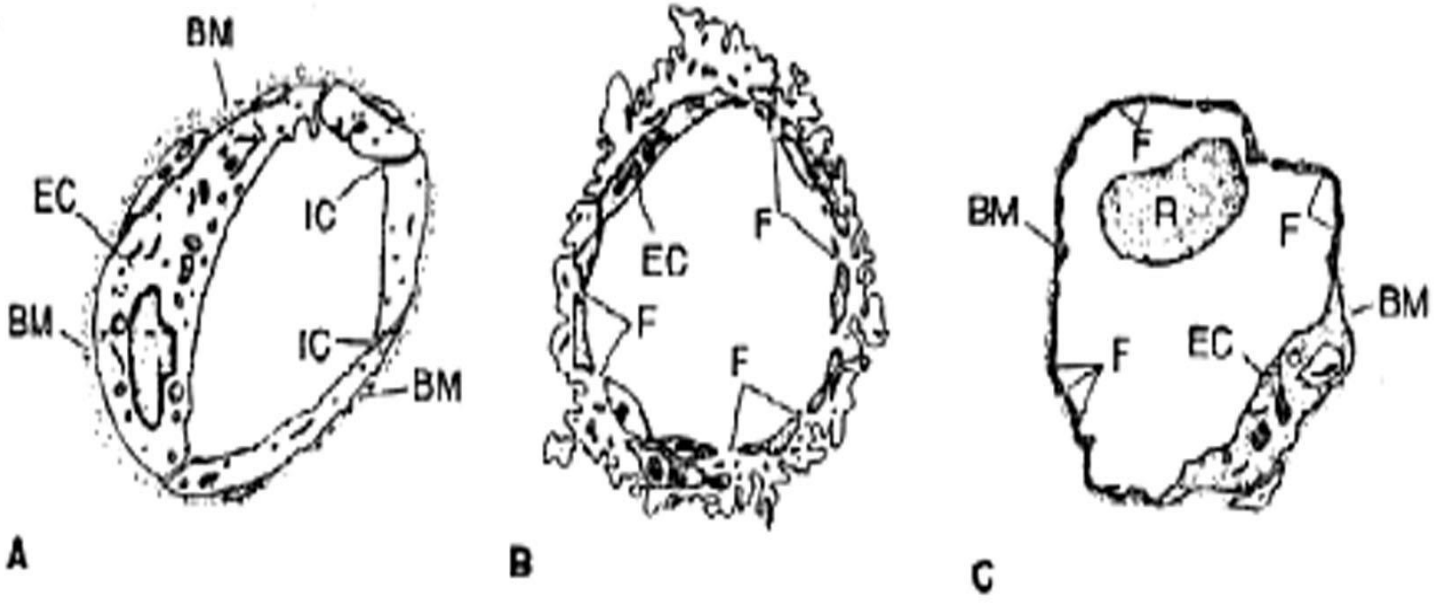
# CHAPTER FIVE

## Cardiovascular transport

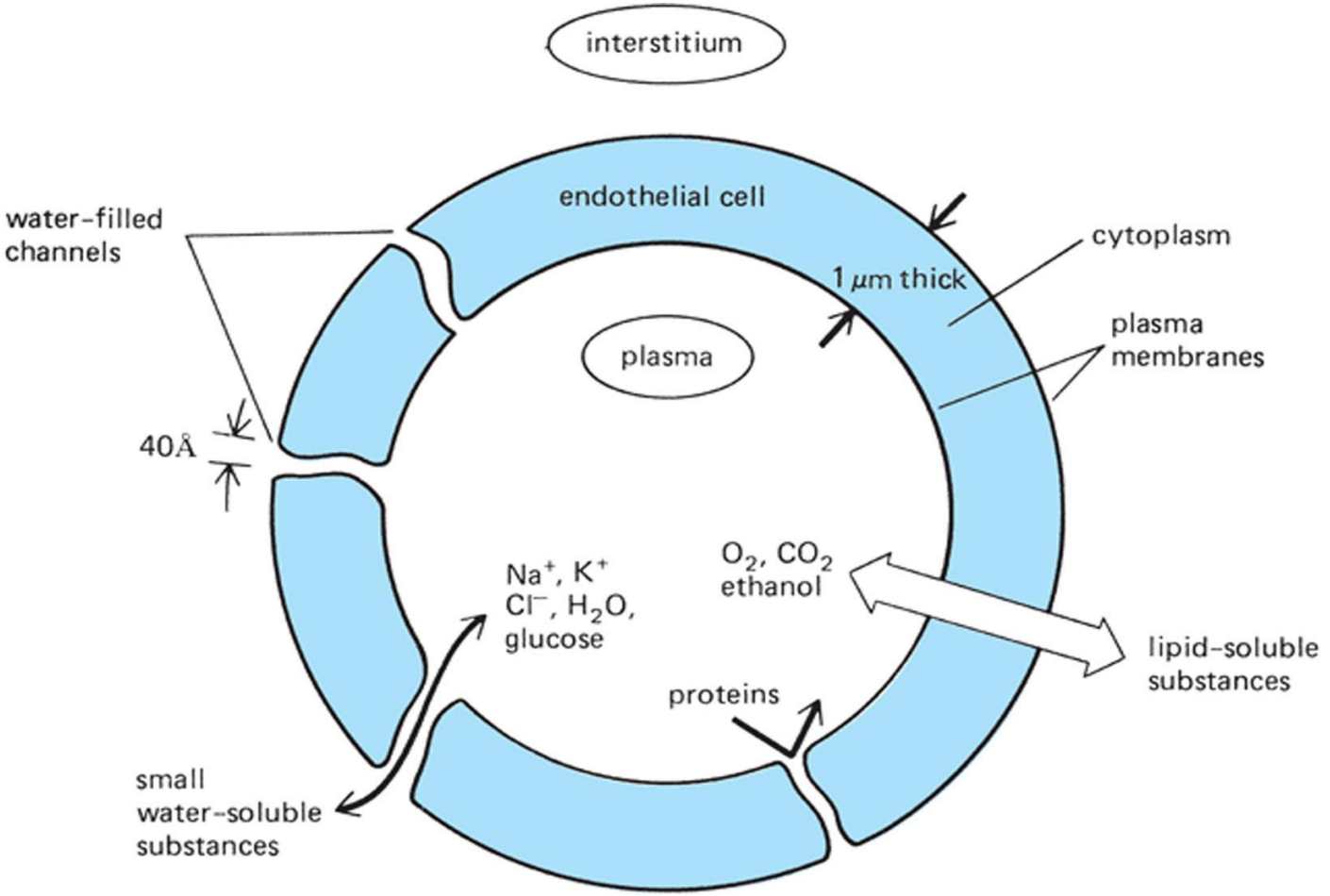
# capillary transports



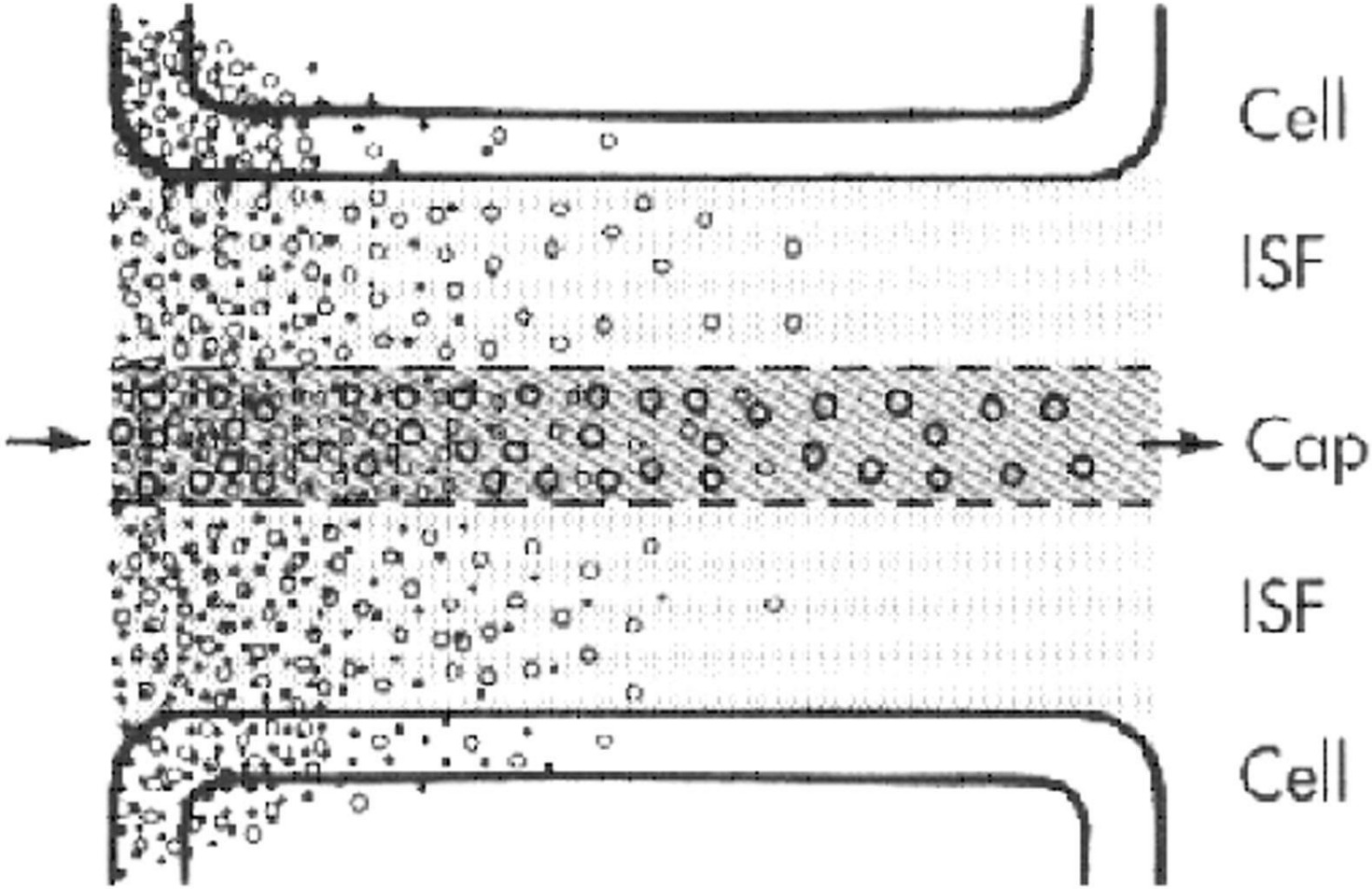
# Endothelial permeability



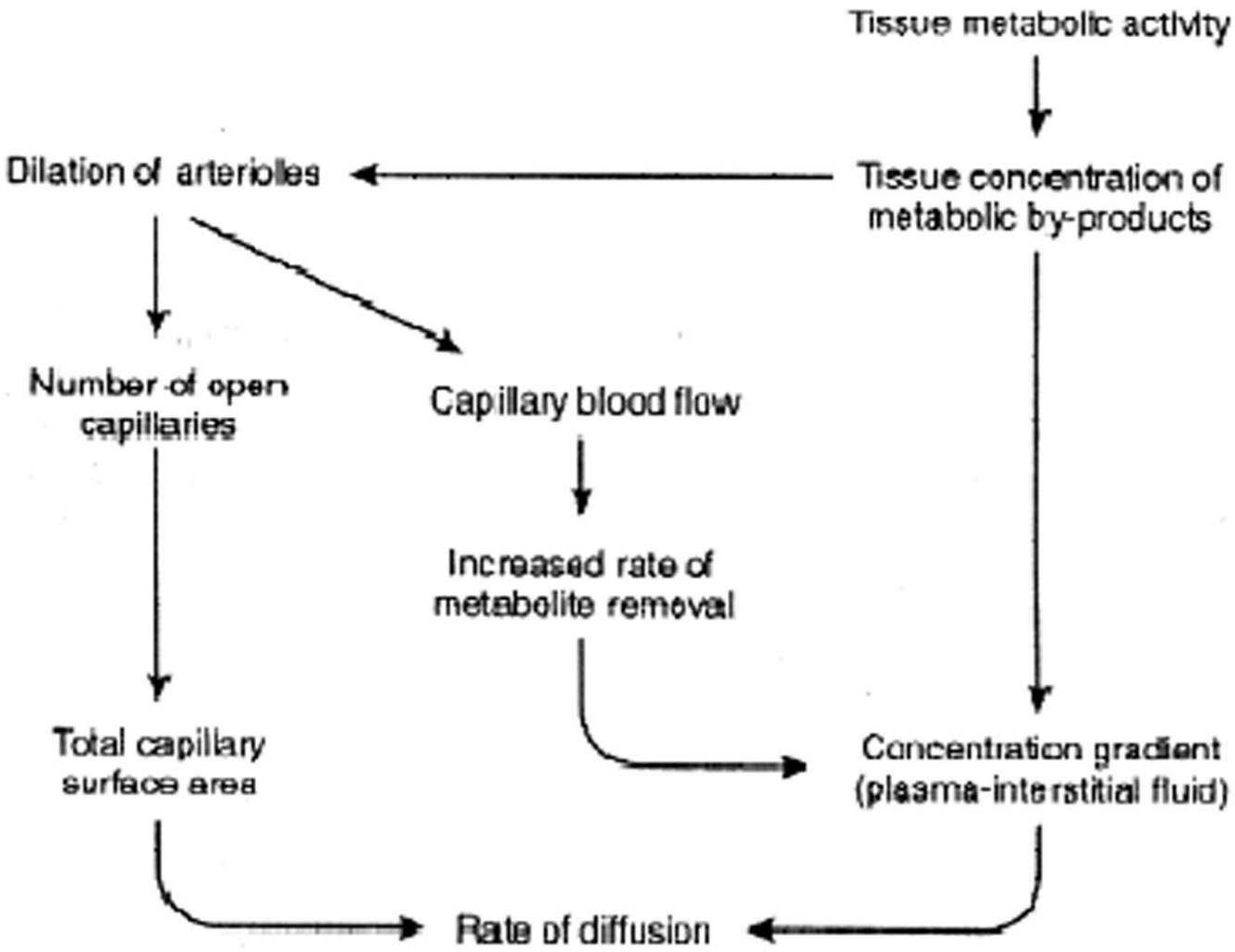
# Pathways for transcapillary solute diffusion



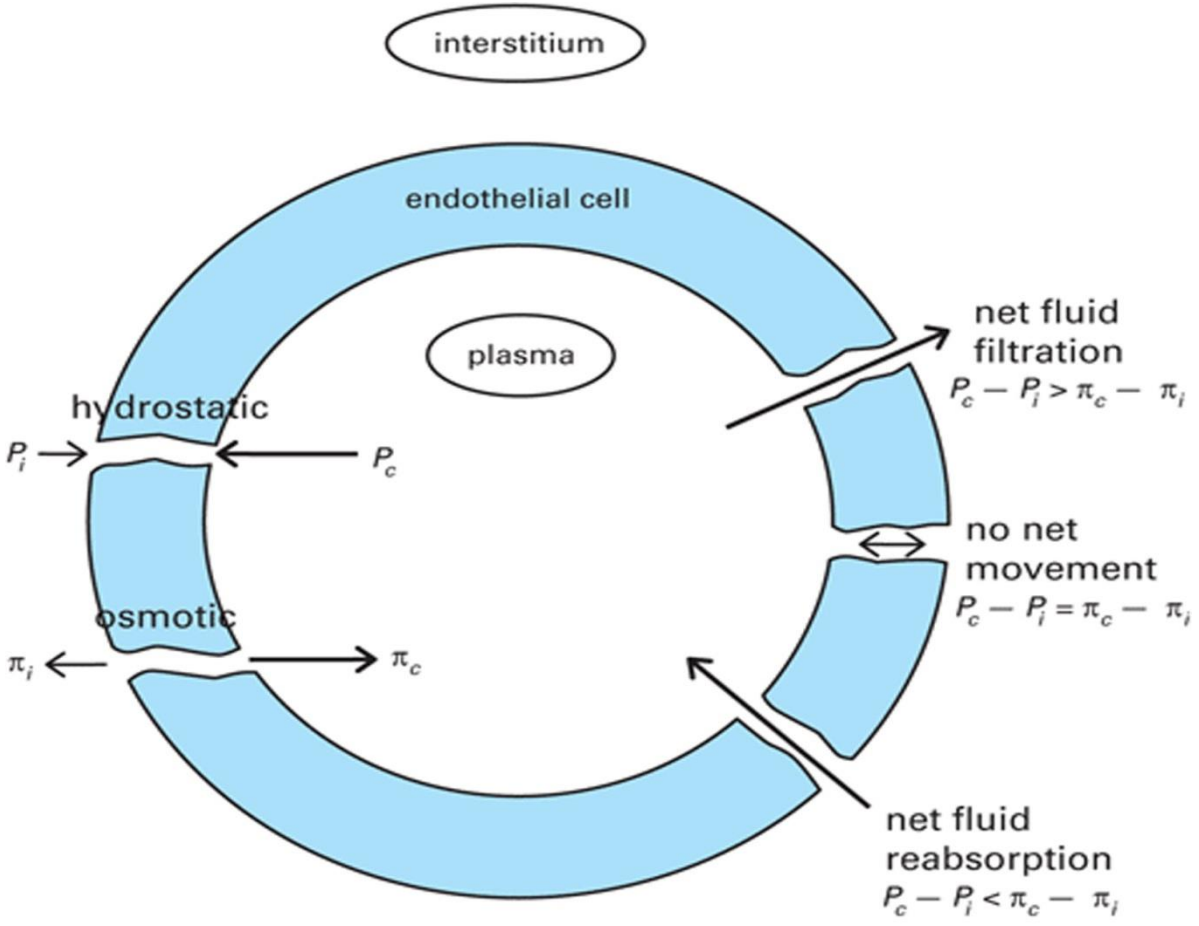
# Capillary diffusion



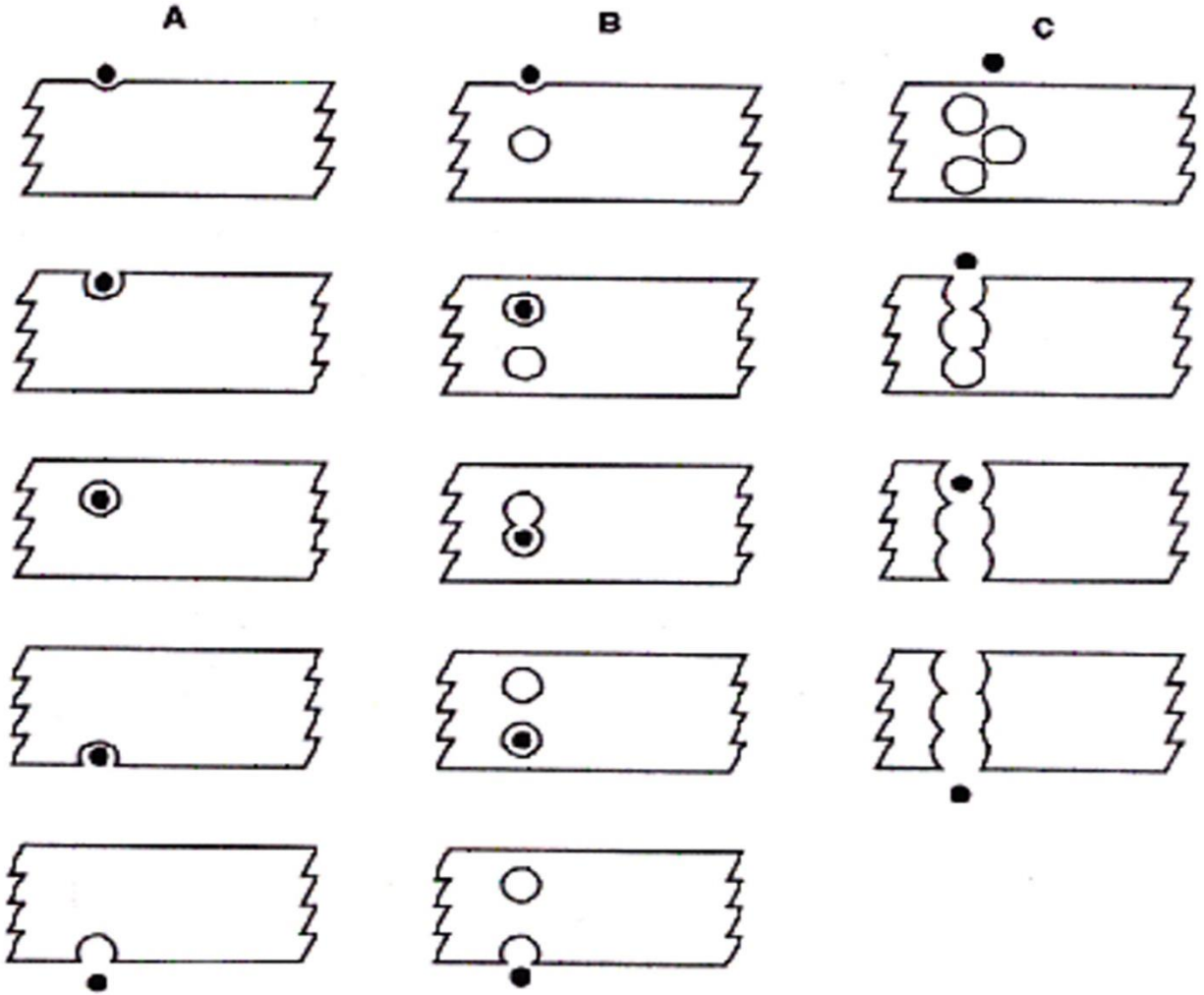
# Tissue metabolism & diffusion rate



# Factors influencing transcapillary fluid movement



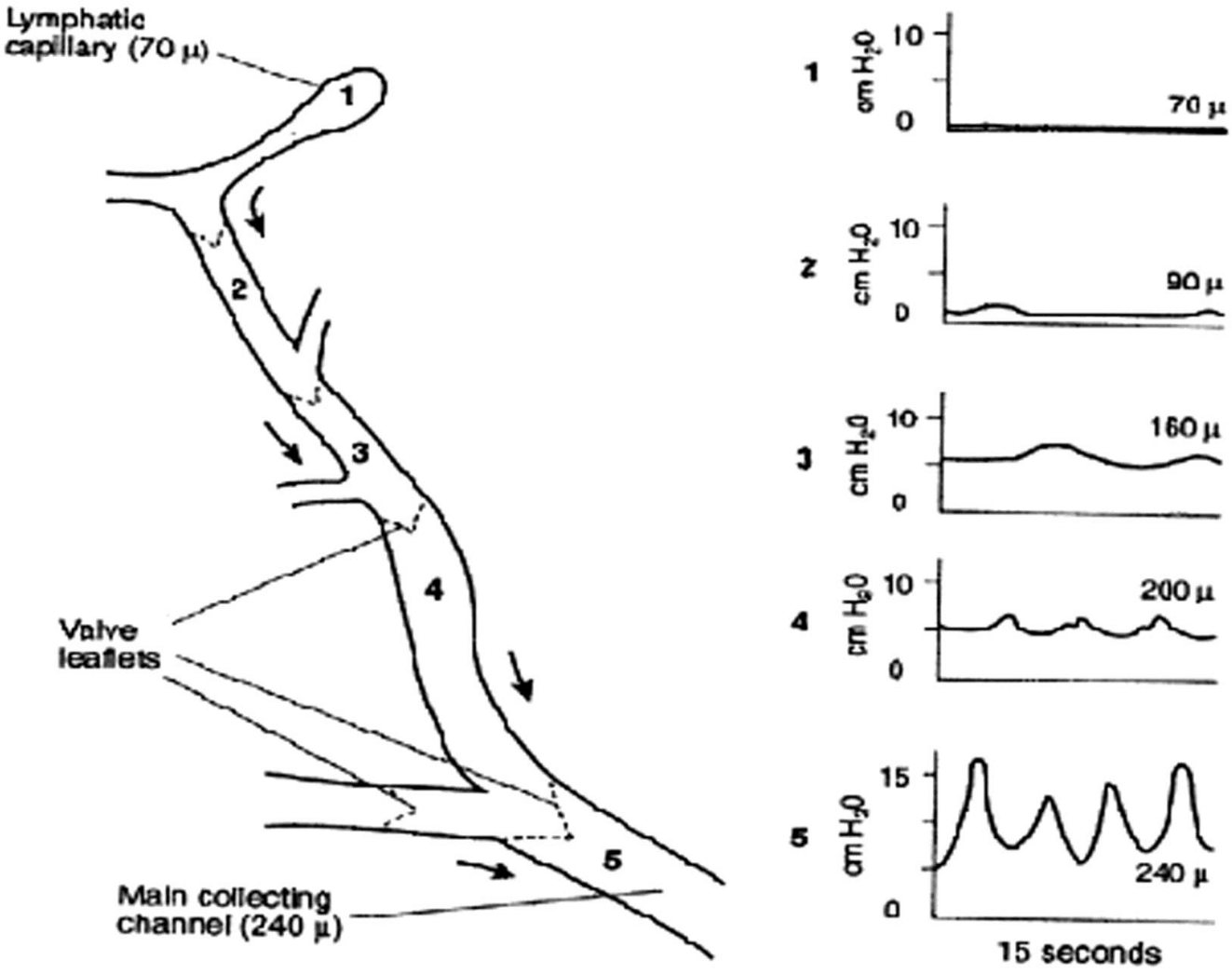
# Vesicular transport



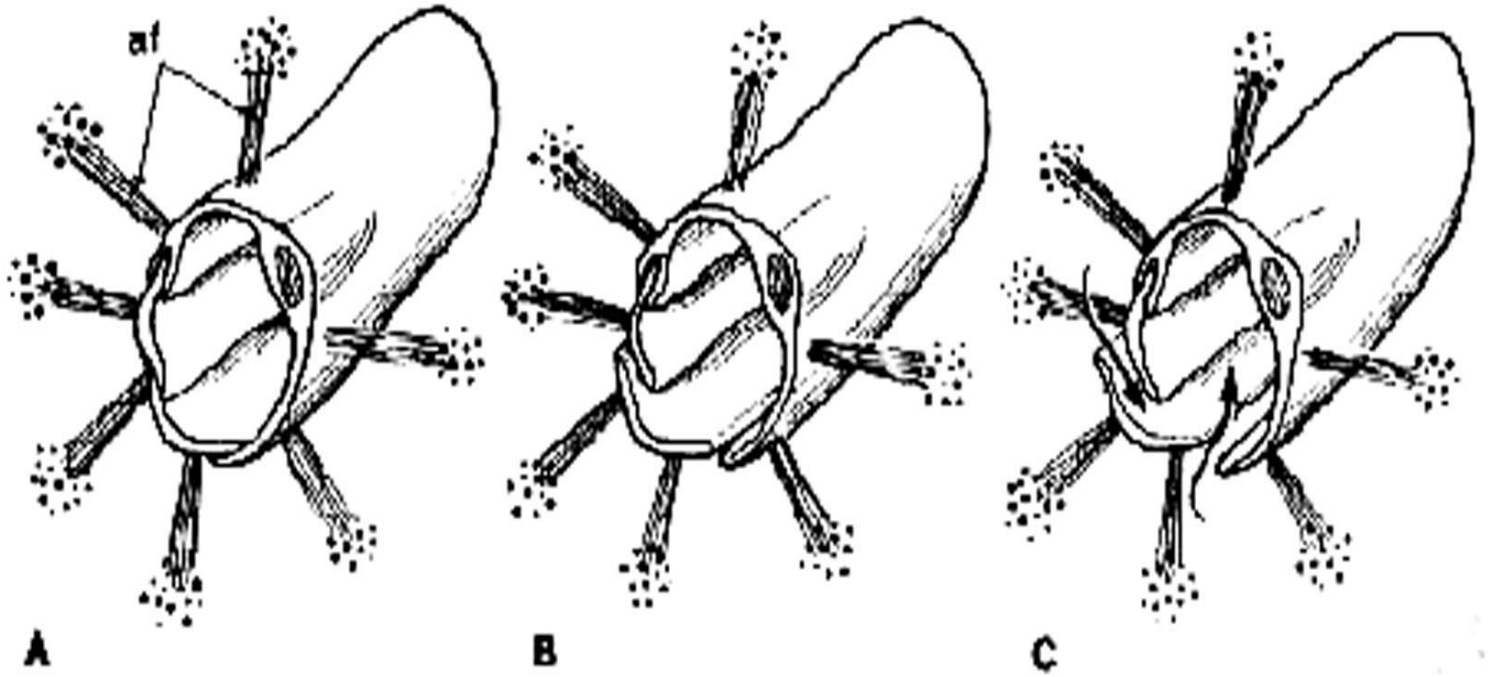
| | Outward Forces | | | Inward Forces | | | |
|---|---|---|---|---|---|---|---|
| | *Pc* | *COPif* | *Sum of Outward* | *COPp* | *Pif* | *Sum of Inward* | *Net (Out–In)* |
| Normal | 26 | 4 | 30 | 28 | 1 | 29 | +1 |
| Vasoconstriction | 20 | 5 | 25 | 28 | 0 | 28 | −3 |
| Vasodilation | 30 | 3 | 33 | 28 | 2 | 30 | +3 |
| Dehydration | 26 | 5 | 31 | 34 | 0 | 34 | −3 |
| Protein loss | 26 | 3 | 29 | 24 | 2 | 26 | +3 |

*Note.* Pc = blood pressure within the capillary; COPIf = colloid osmotic pressure in the interstitial fluid; COPp = colloid osmotic pressure created by plasma proteins; Pif = pushing force in the interstitial fluid.

# Lymphatic flow



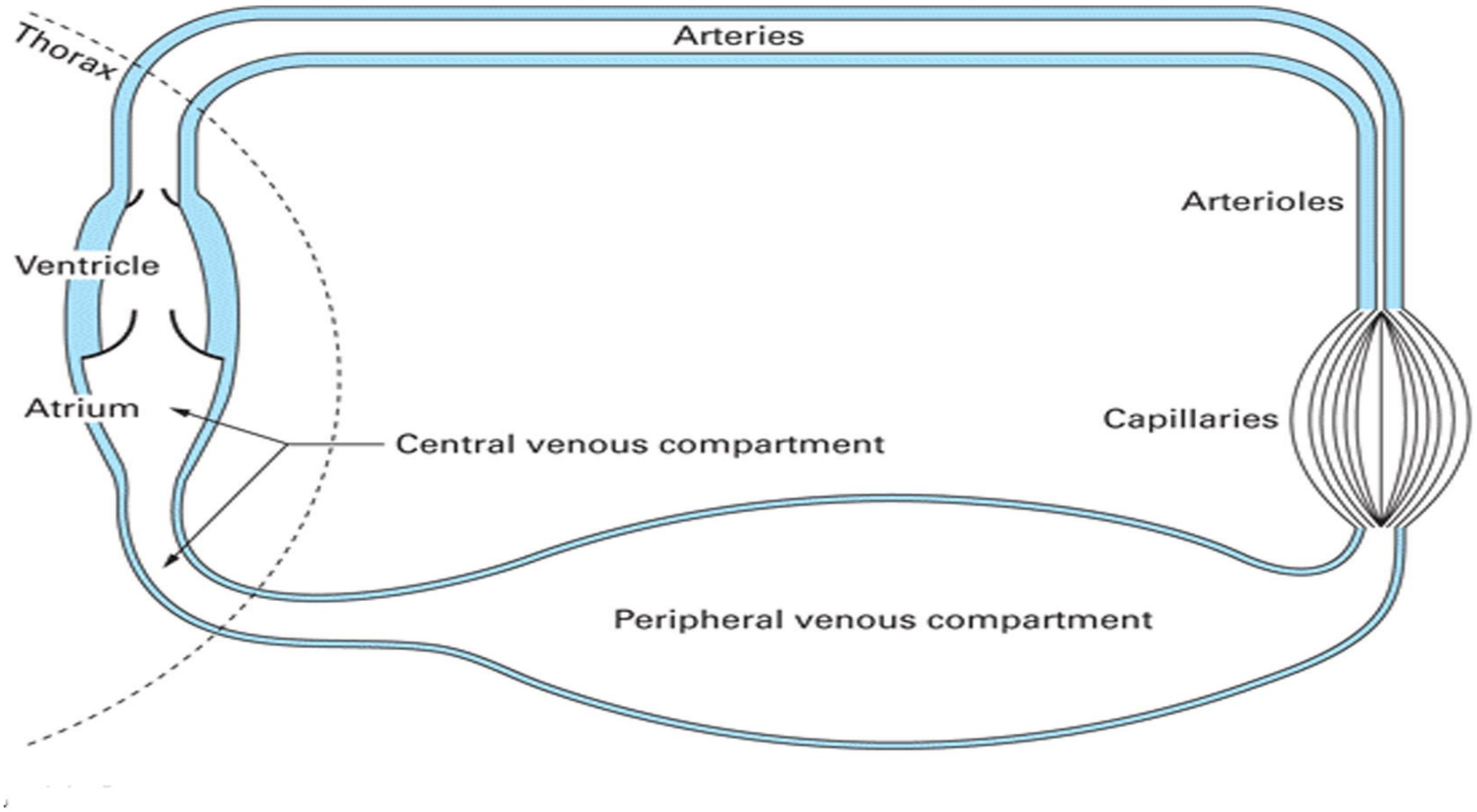
# Fluid movement through lymphatic vessels



# CHAPTER SIX

## Interaction of system components

# Major functionally distinct components of the systemic cardiovascular circuit

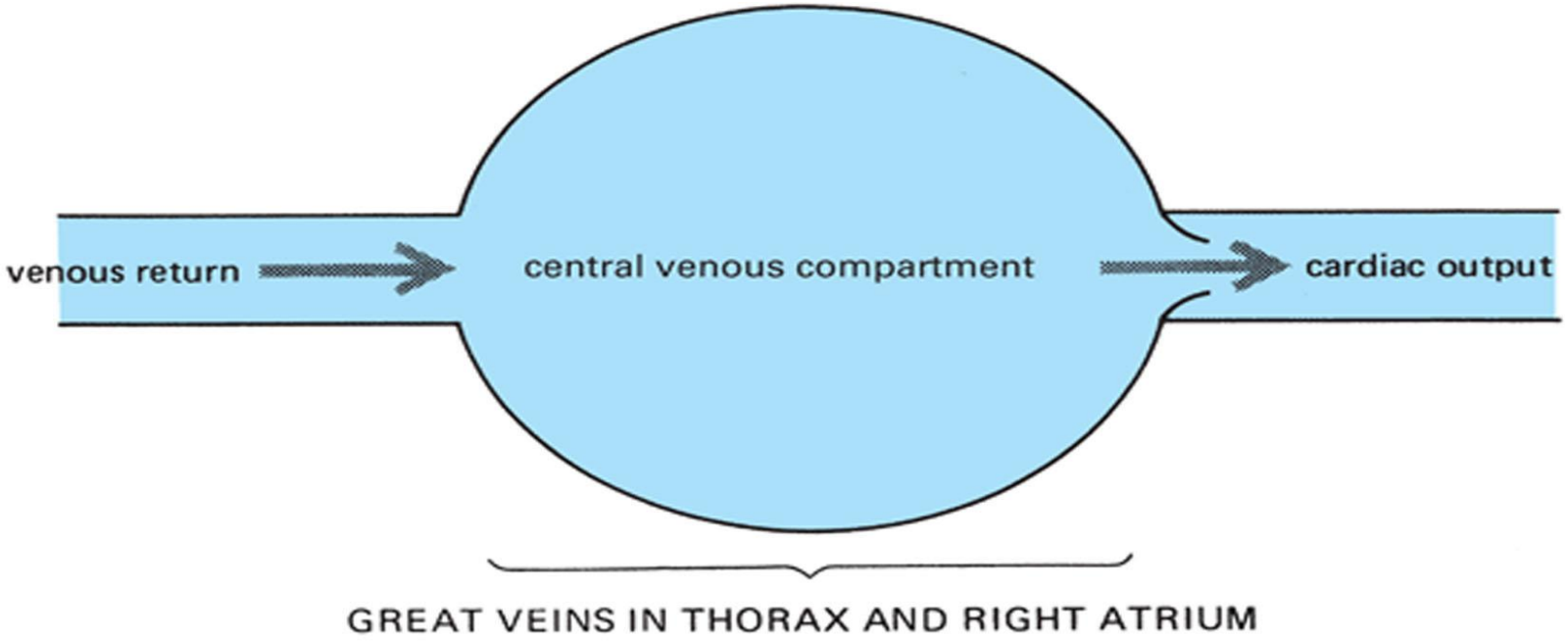


# Typical properties of the major components of the systemic cardiovascular circuits

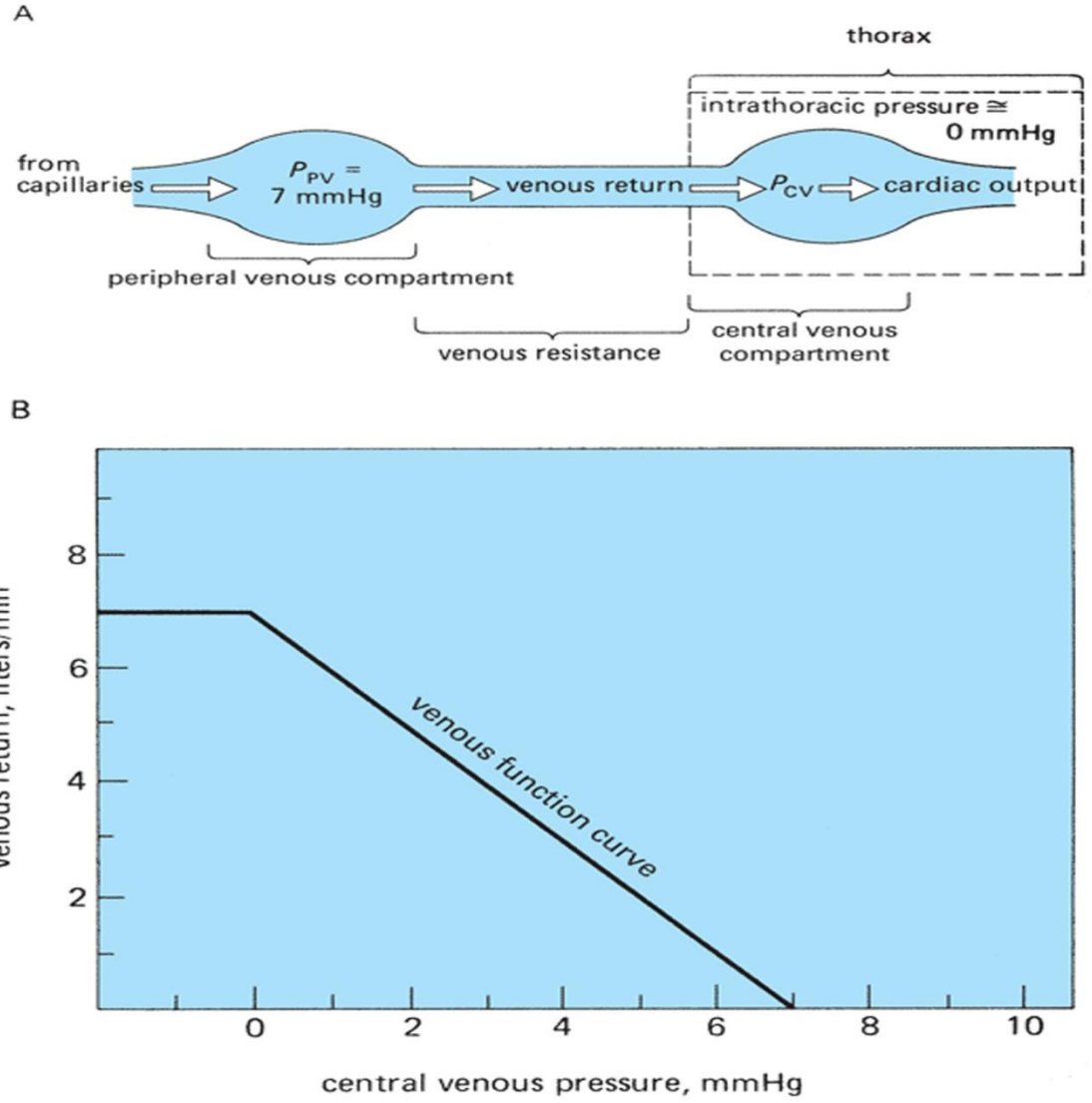
| Compartment | $V_0$ mL | $C$ mL/mmHg | $R$ mmHg/(L/min) |
|---|---|---|---|
| Ventricle in diastole | 30 | 24 | 0 |
| Arteries | 600 | 2 | 1 |
| Arterioles | 100 | 0 | 13 |
| Capillaries | 250 | 0 | 5 |
| Peripheral venous compartment | 2500 | 110 | 1 |
| Central venous compartment | 80 | 4 | 0 |
| Entire circuit | 3560 | 140 | 20 |

*Values are for a normal, young, resting 70-kg adult. $V_0$, anatomical volume of compartment at zero pressure; $C$, compliance of compartment; $R$, resistance to flow through compartment.

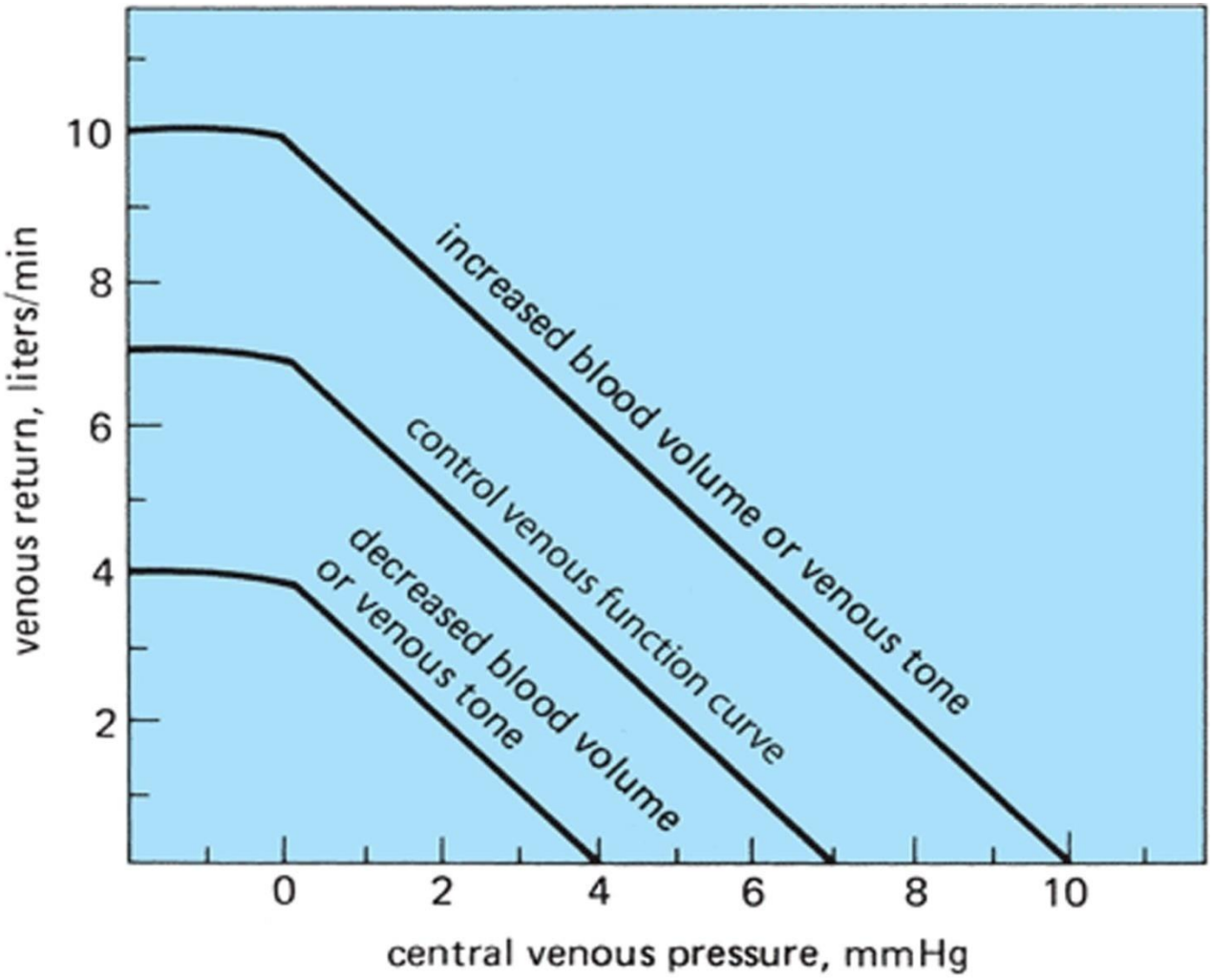
# Distinct between cardiac output & venous return



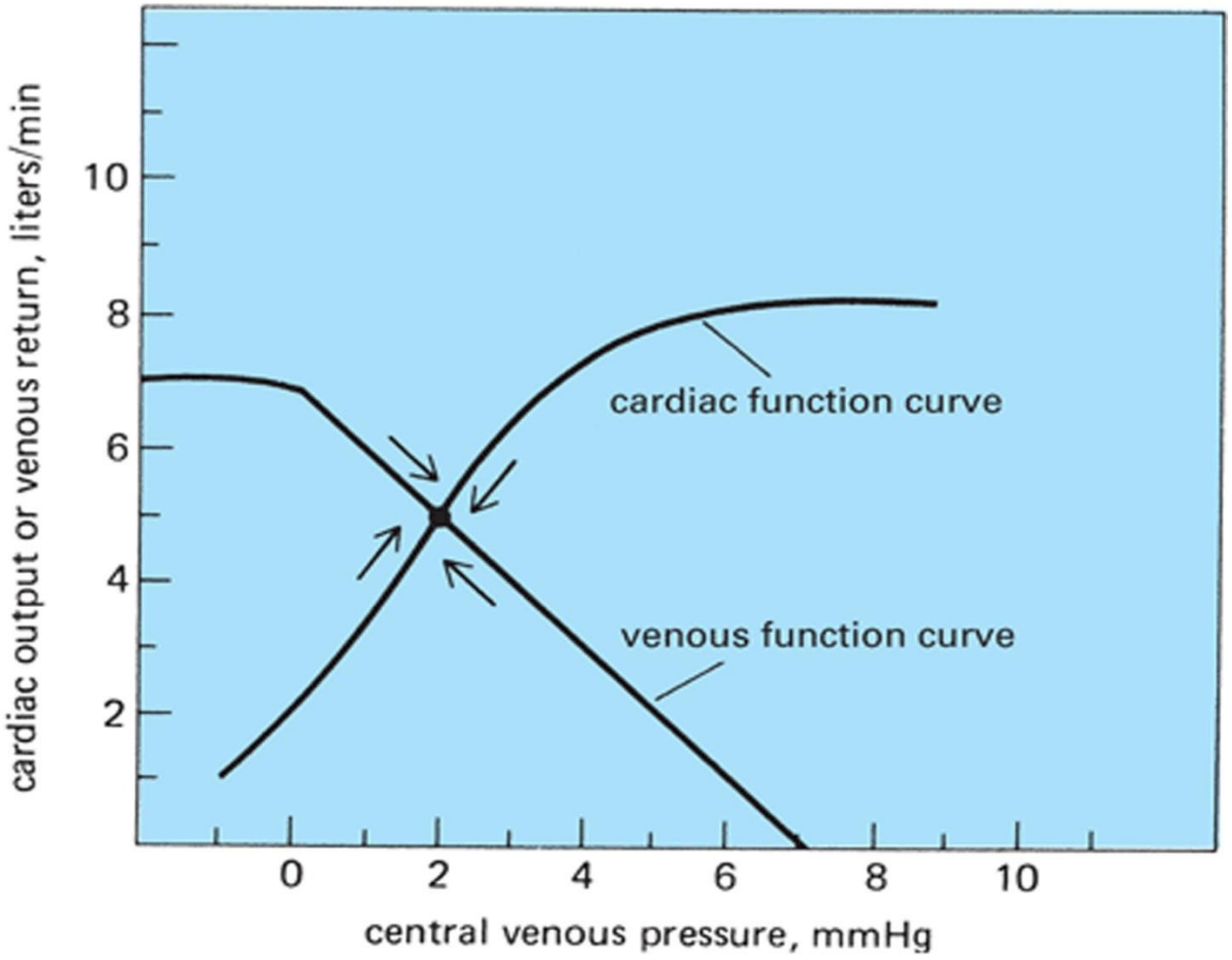
# A: Factors influencing venous return
# B: the venous function curve



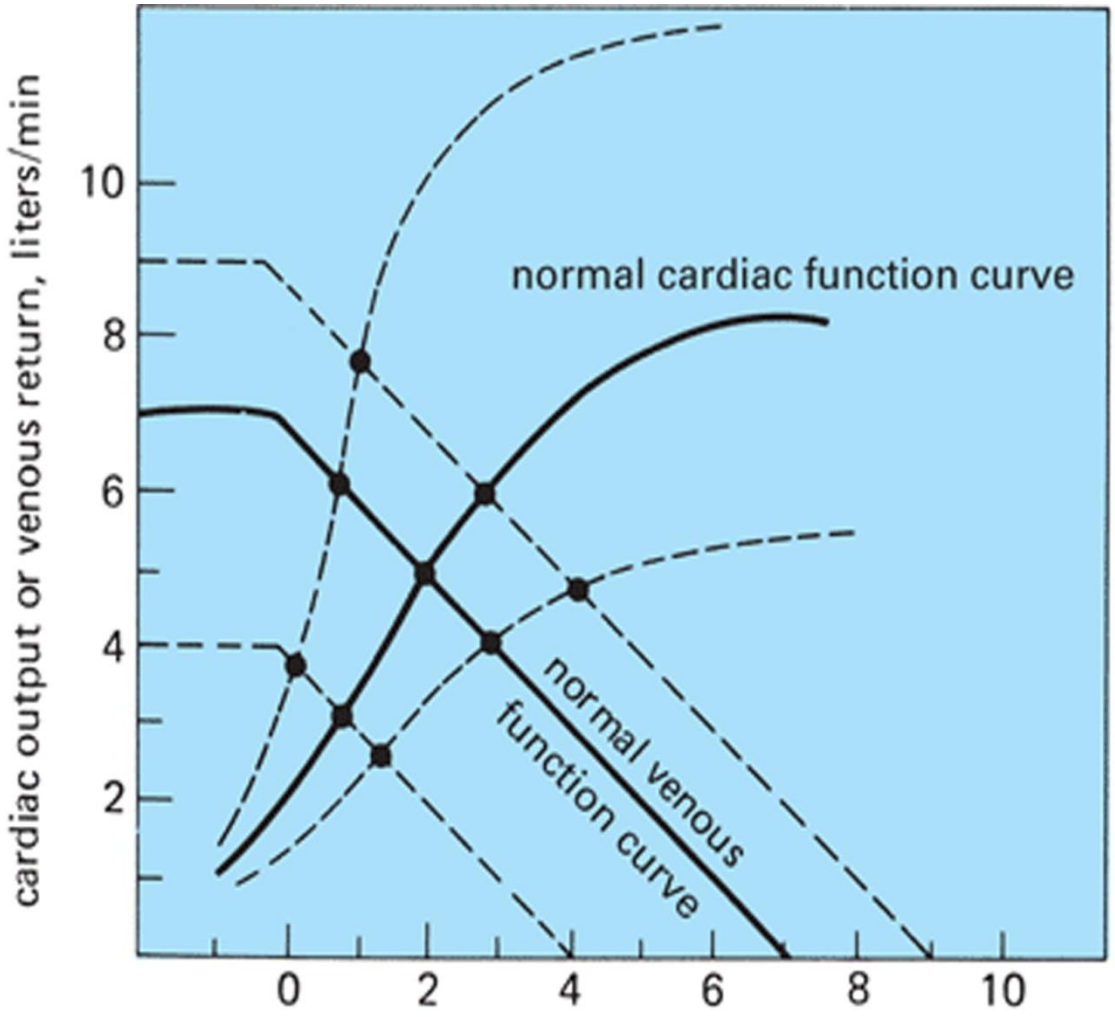
# Effect of changes in blood volume & venous tone on venous function curves



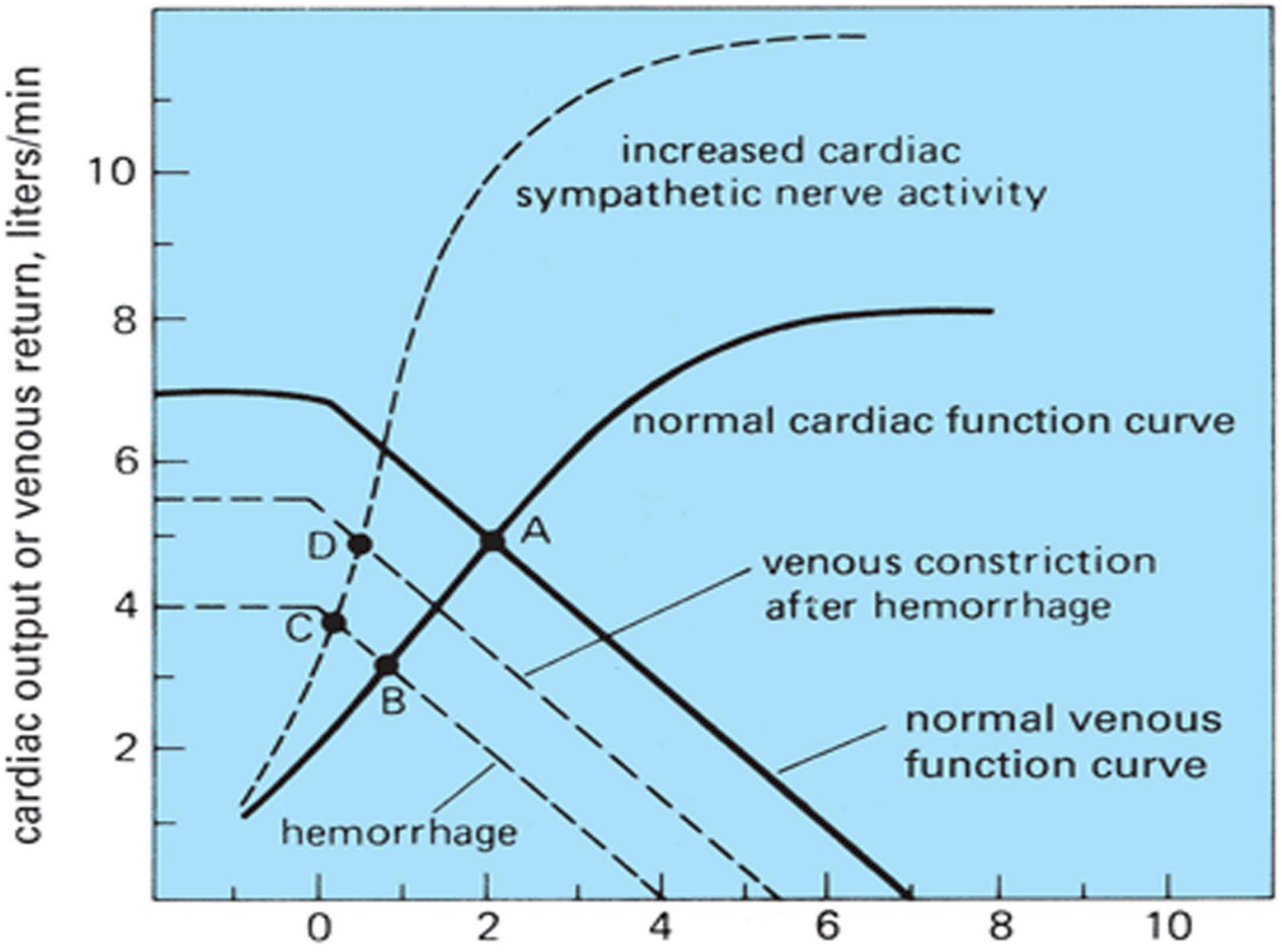
# Interaction of cardiac output and venous return through central venous pressure



# Families of cardiac function and venous function curves



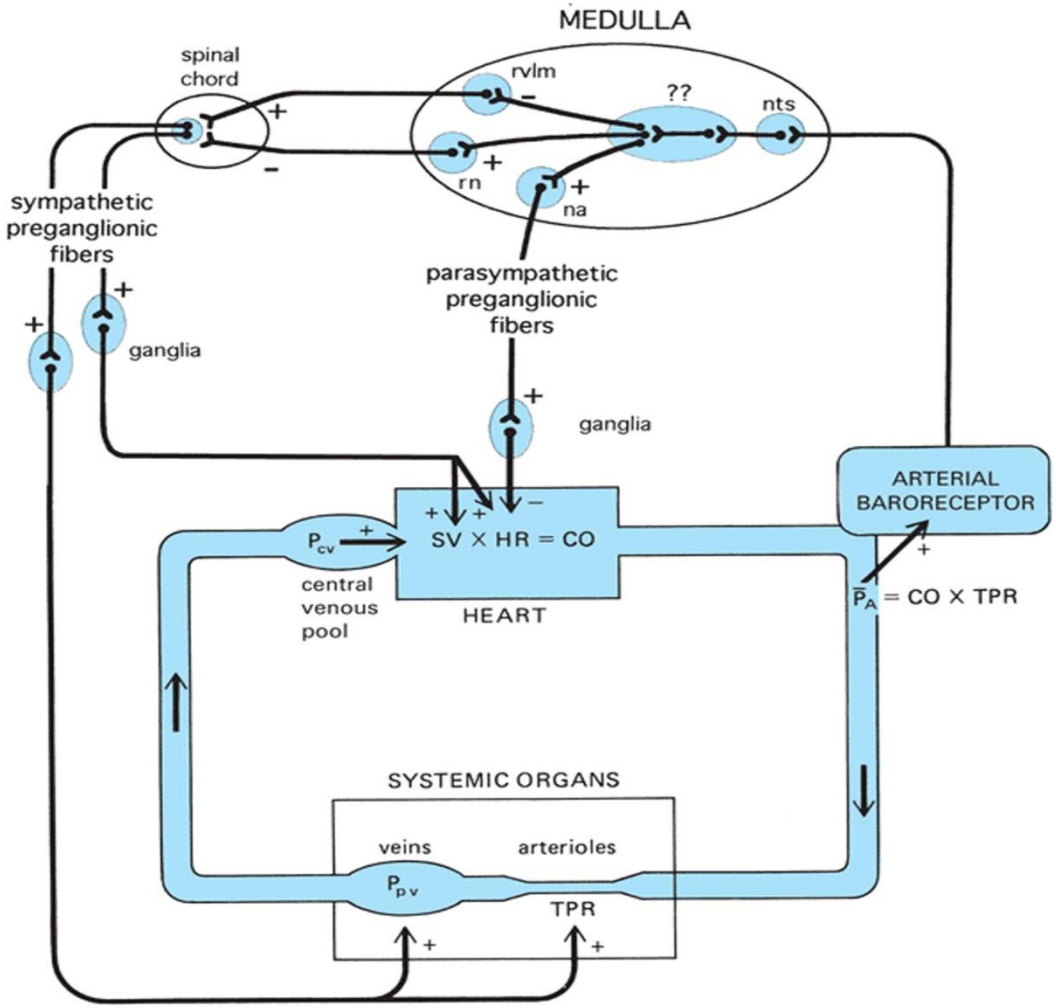
# Cardiovascular adjustments to hemorrhage



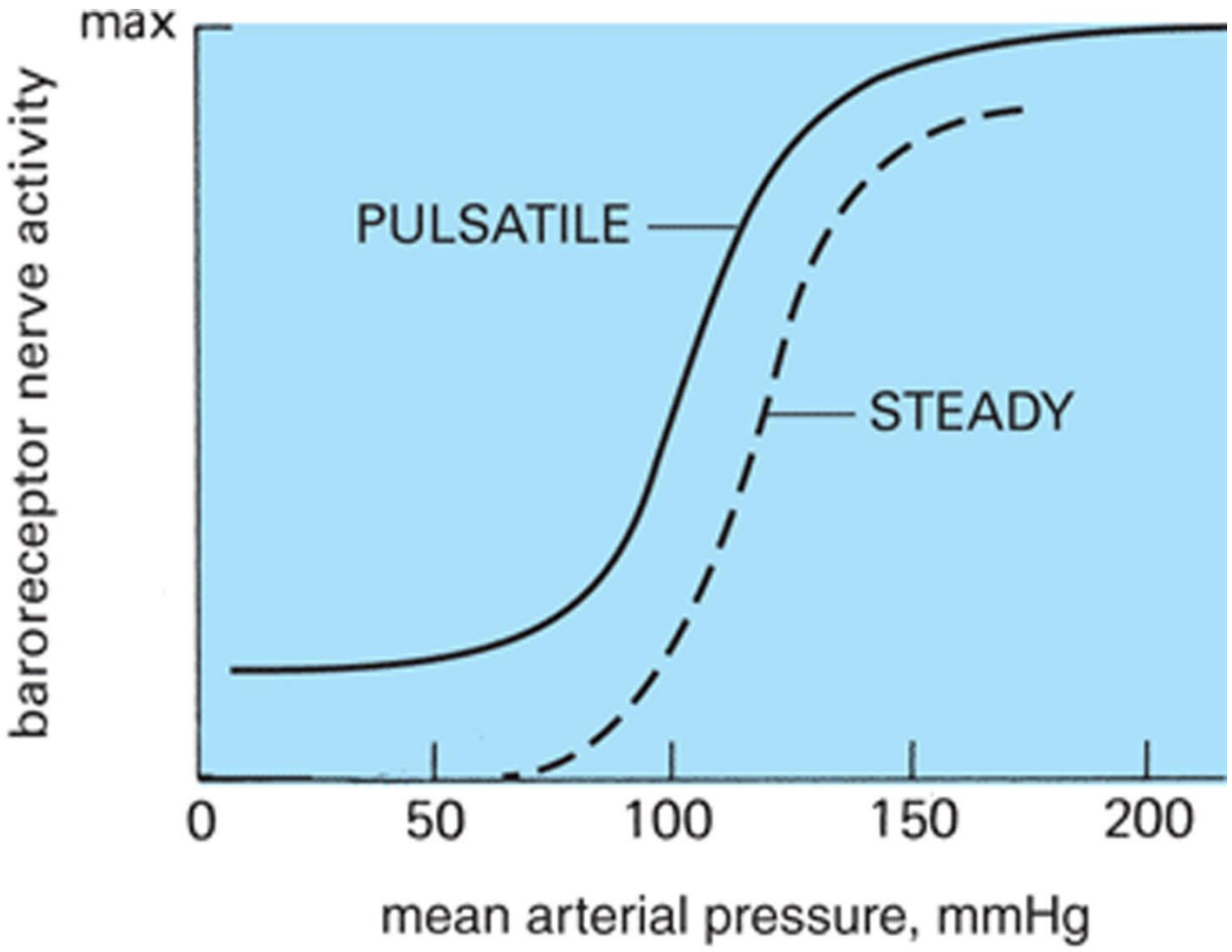
# CHAPTER SEVEN

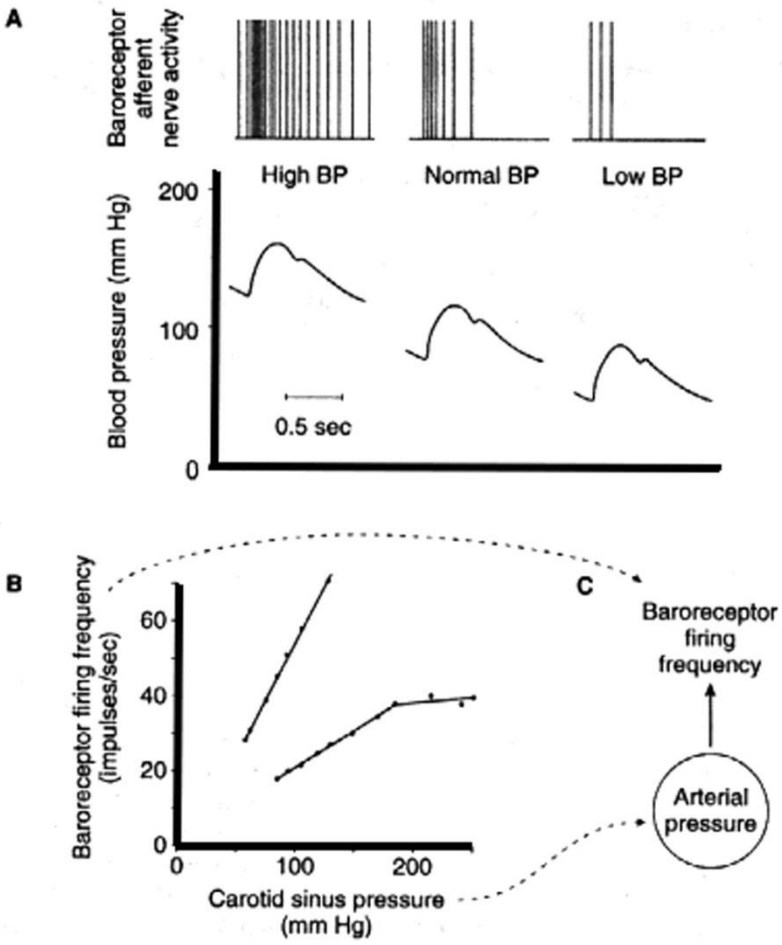
## Blood pressure regulatory mechanisms

# Compartments of arterial baroreceptor reflex pathway

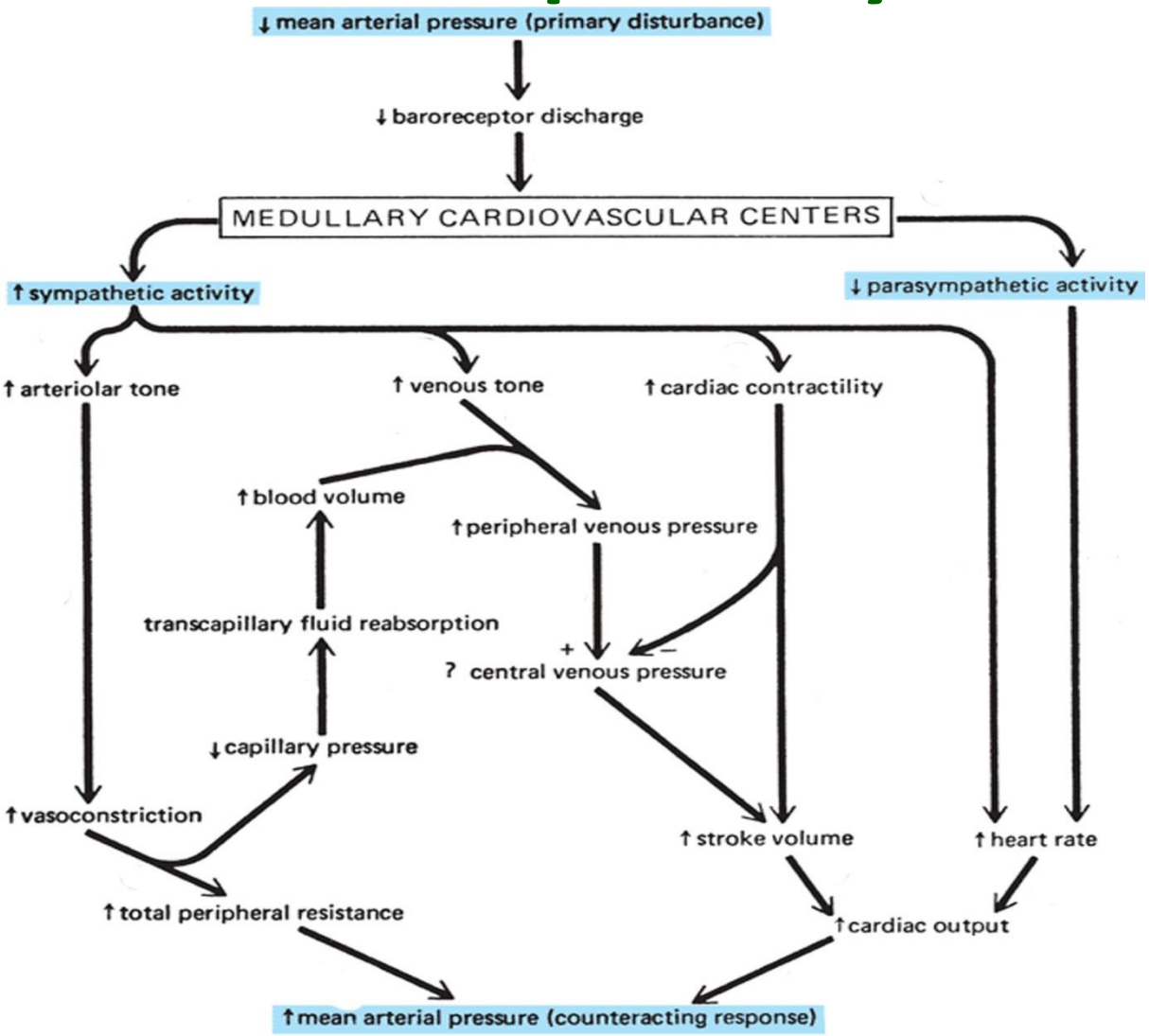


# Effect of mean arterial pressure on baroreceptor nerve activity

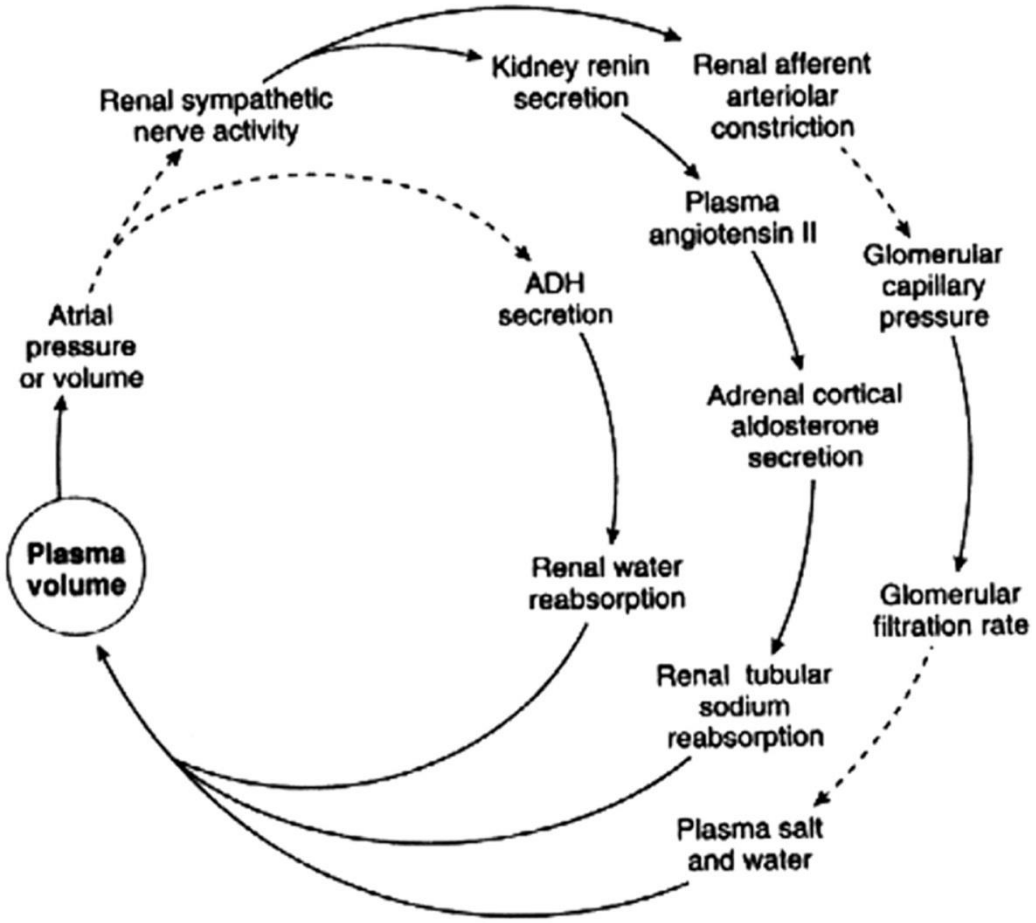



A
Baroreceptor afferent nerve activity
High BP
Normal BP
Low BP
Blood pressure (mm Hg)
200
100
0
0.5 sec
B
Baroreceptor firing frequency (impulses/sec)
60
40
20
0
0
100
200
Carotid sinus pressure (mm Hg)
C
Baroreceptor firing frequency
Arterial pressure

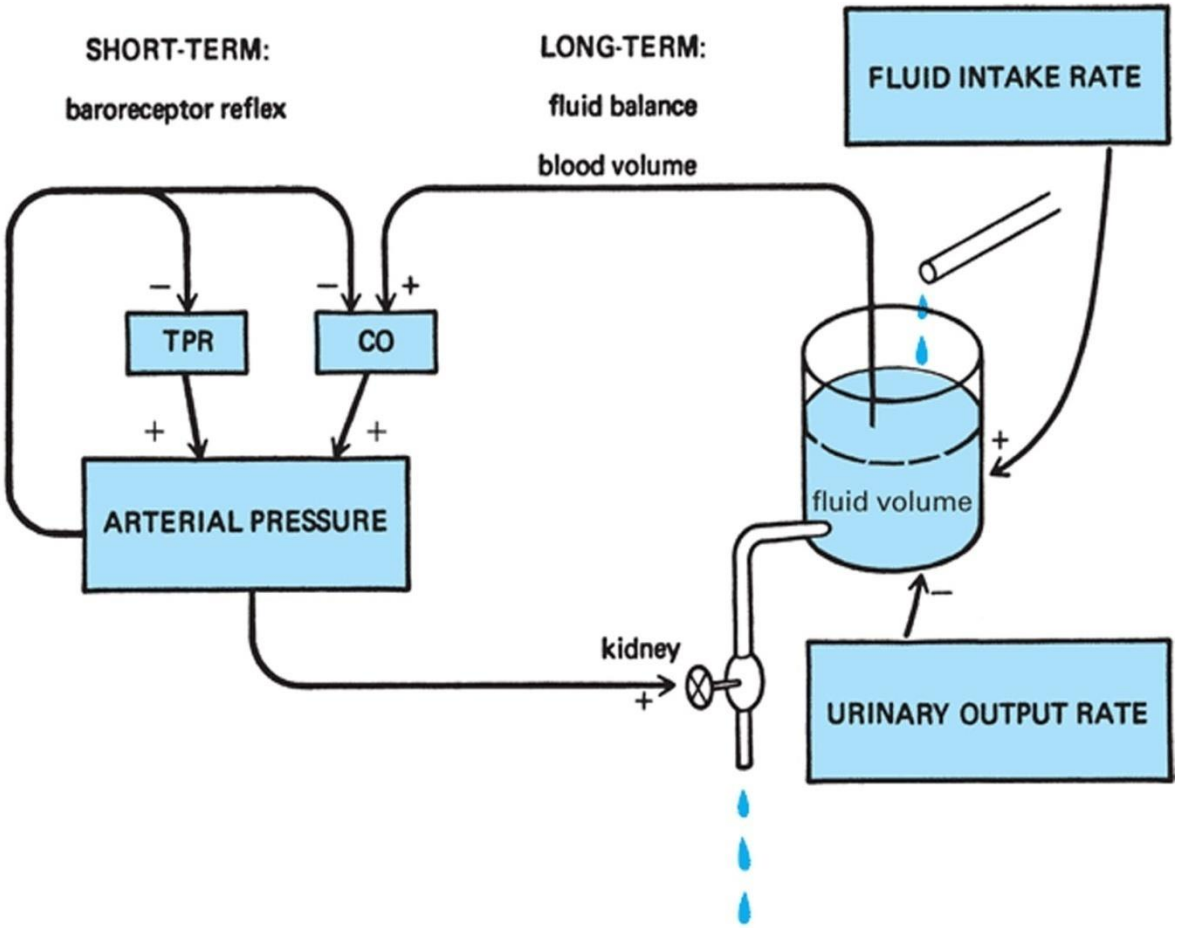
# Events in the arterial baroreceptor reflex pathway



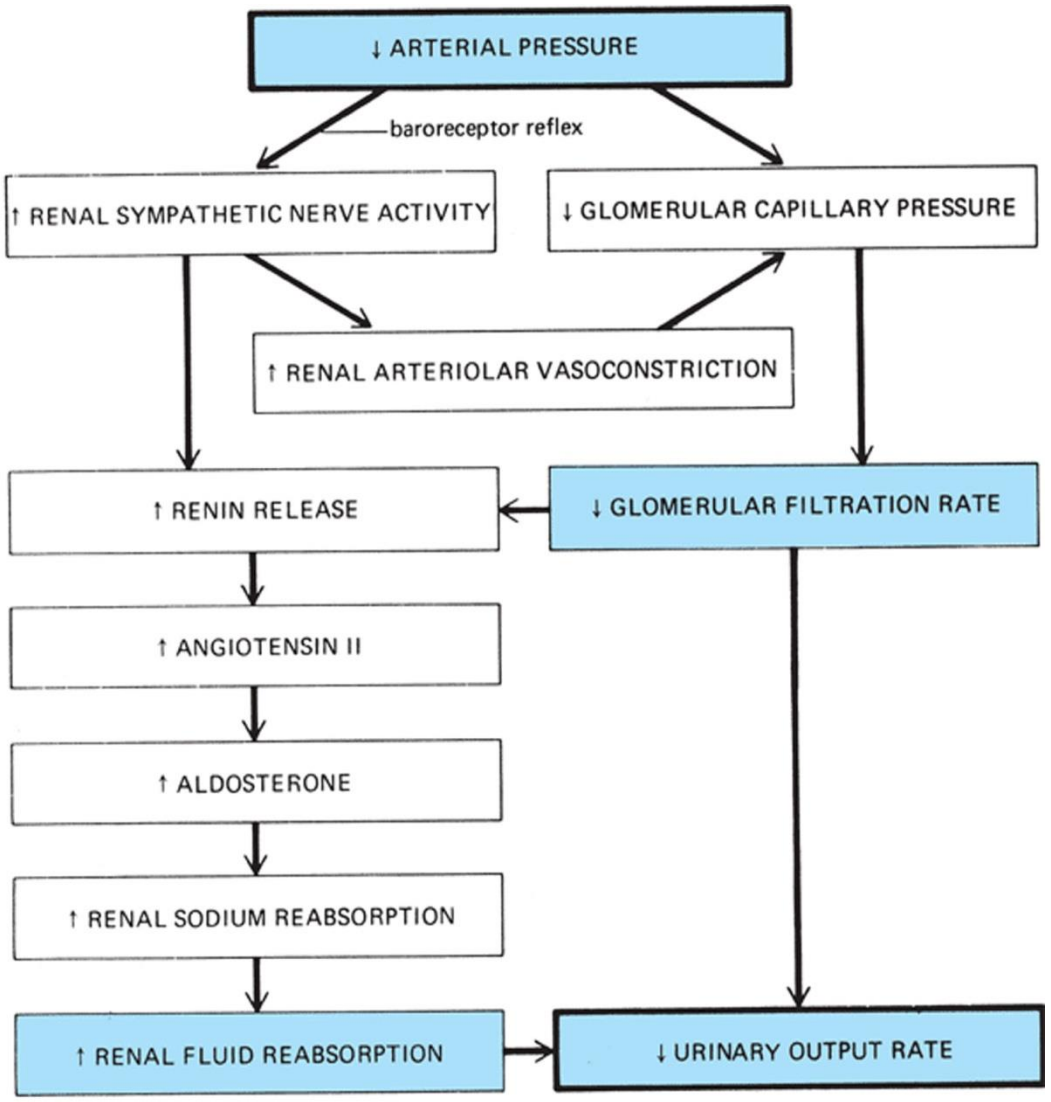
# Compartments of low pressure receptor reflex pathway



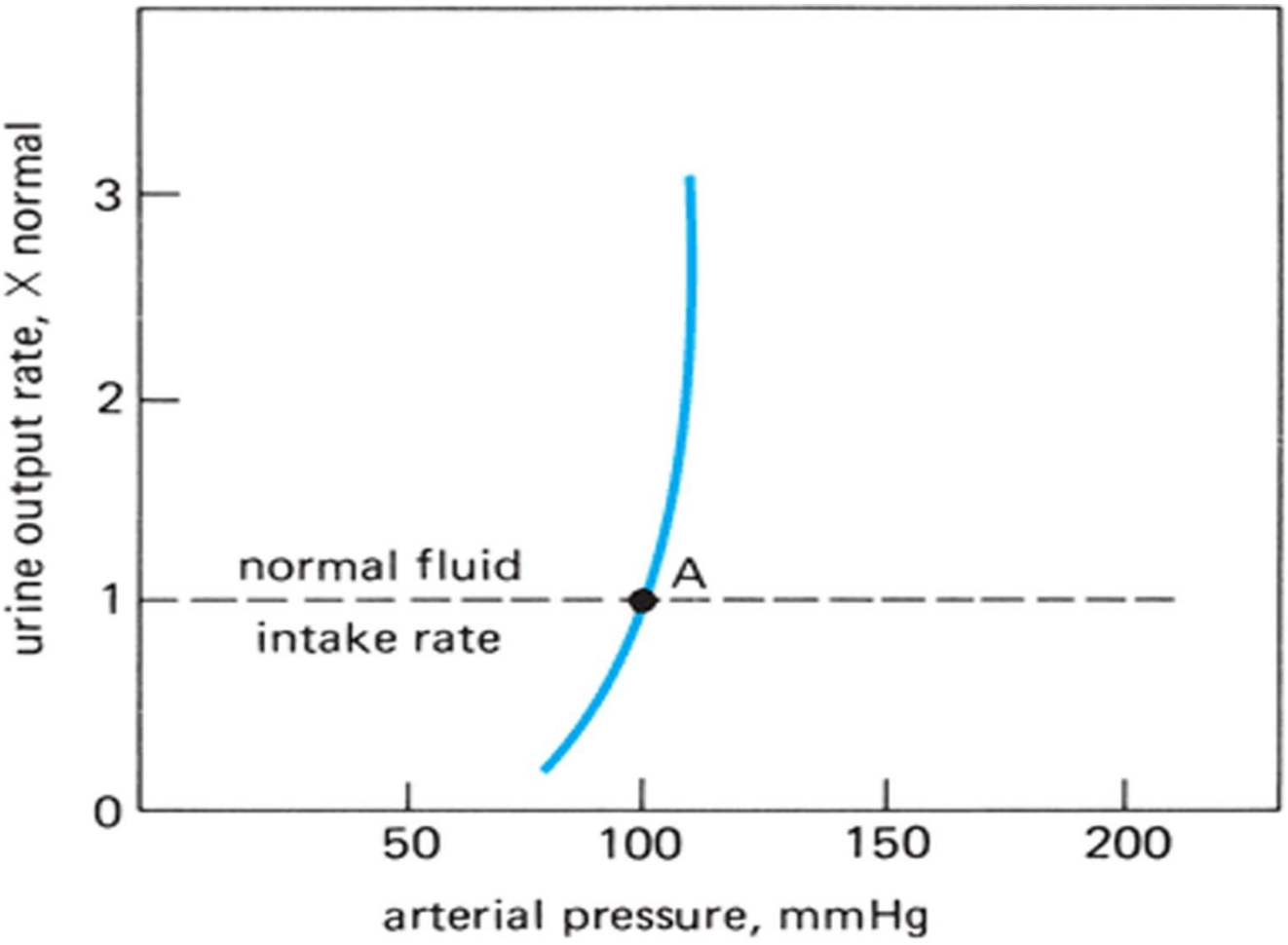
# Mechanisms of short- and long-term regulation of arterial pressure



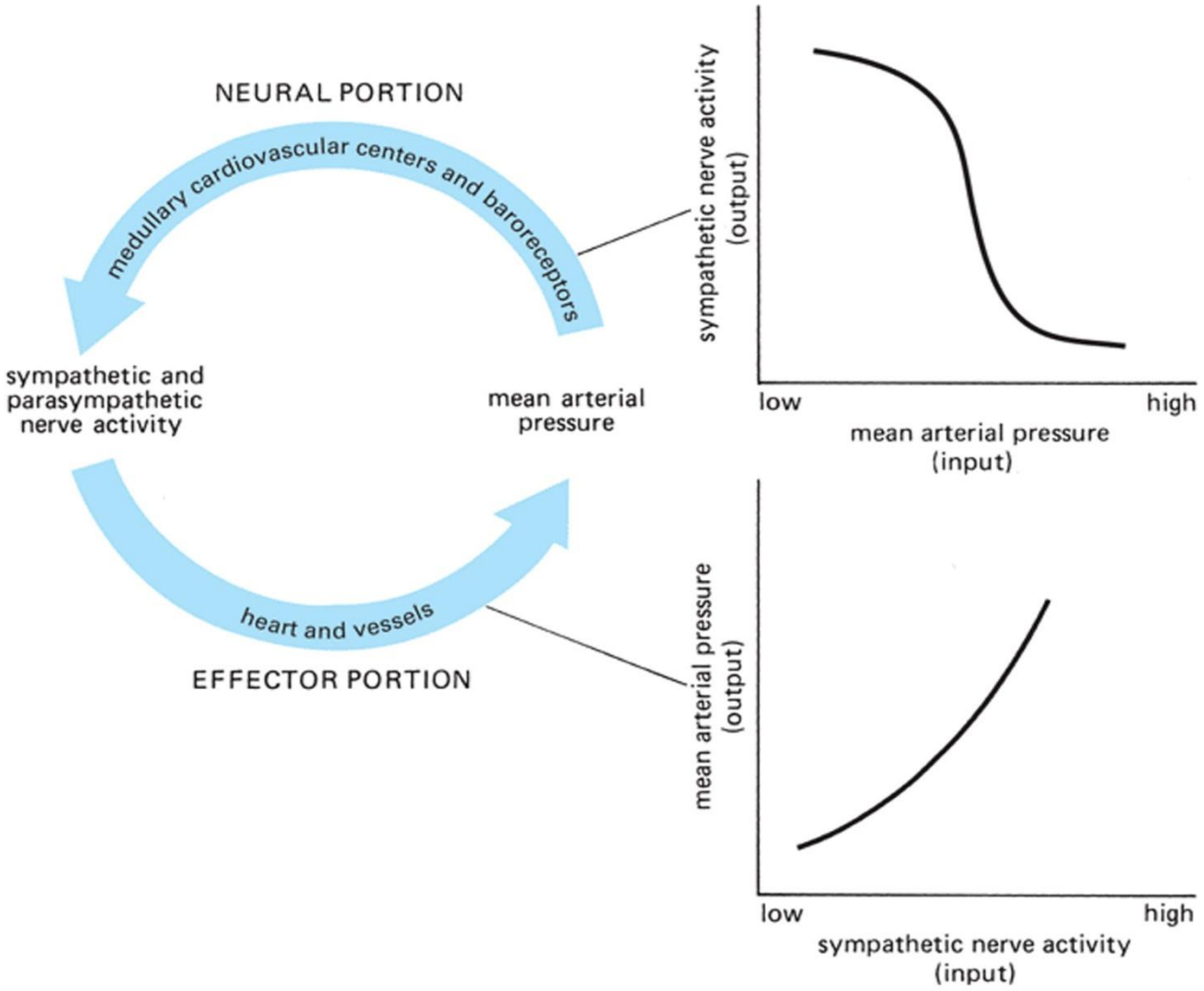
# Mechanisms by which arterial pressure influences urinary output



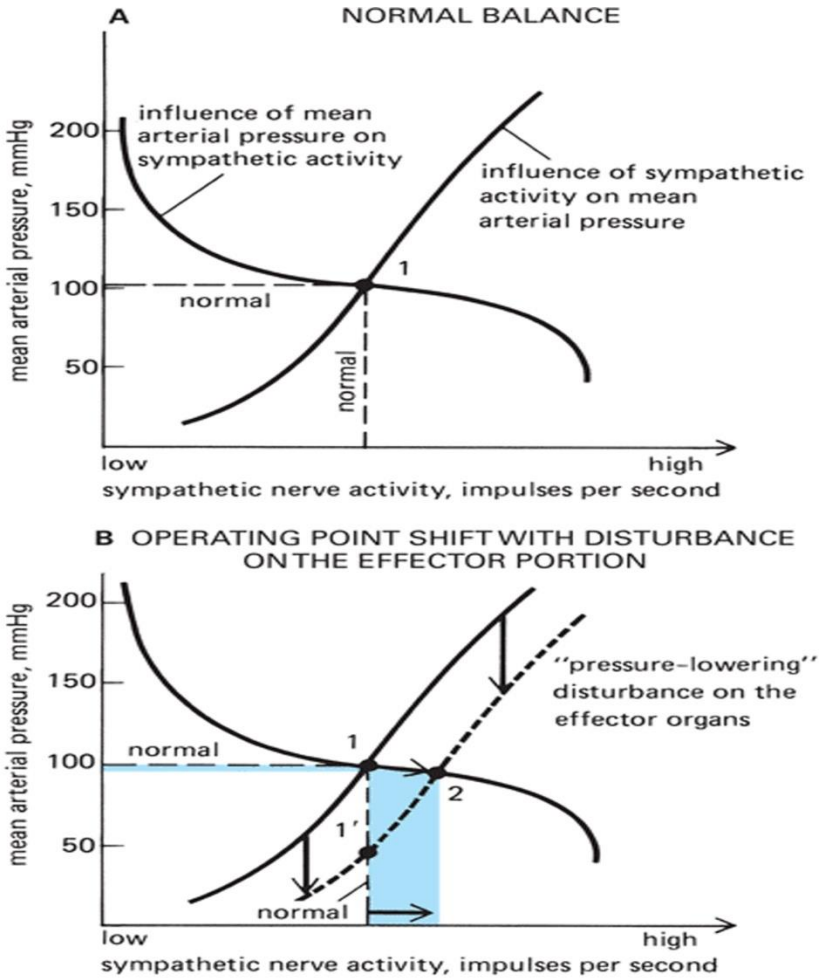
# Effect of arterial pressure on urinary output rate in a normal person



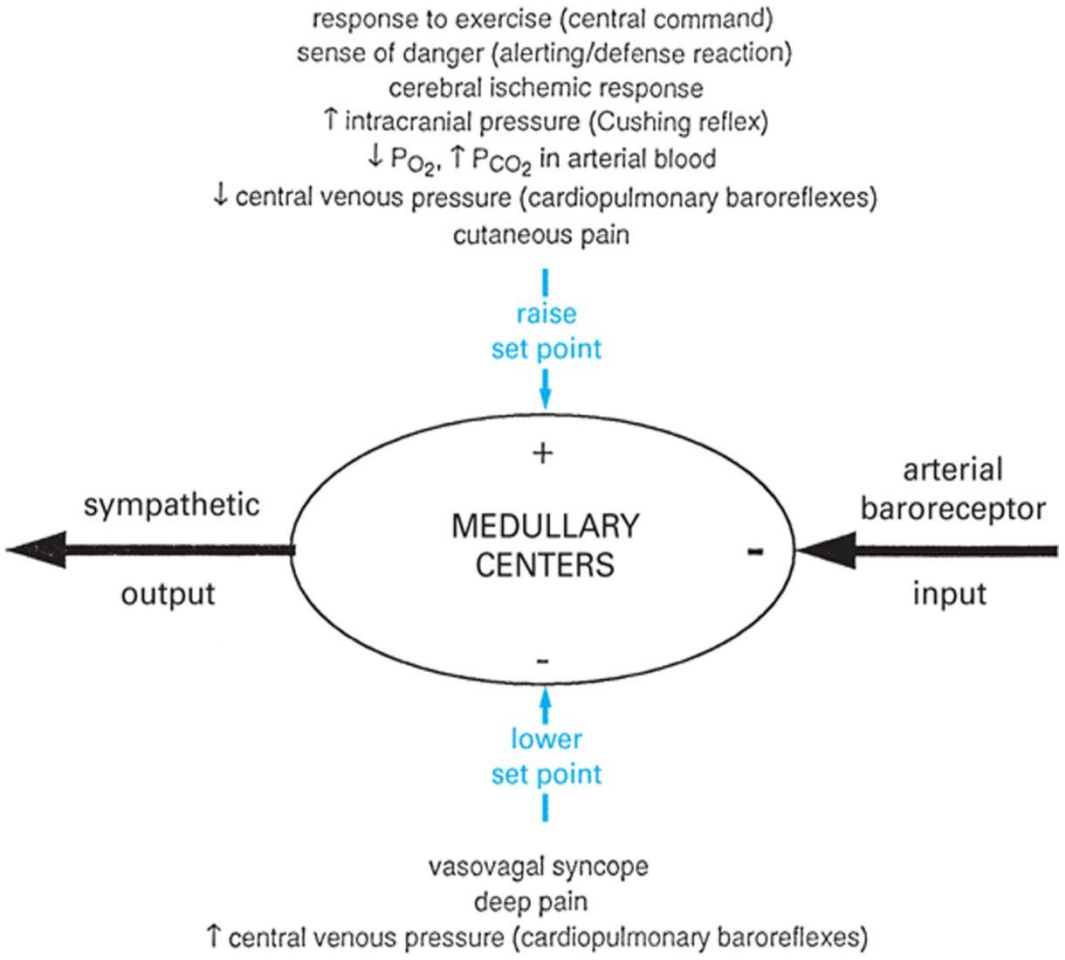
# Neural & effector portions of the arterial baroreceptor control system



# Operation of the arterial baroreceptor control system



# Summary of the factors that influence the set point of the arterial baroreceptor reflex



# Effect of neural influences on the arterial baroreceptor control system