

# Arterial Hypertension

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**This presentation includes only the most important terms and facts. Its content by itself is not a sufficient source of information required to pass the Physiology exam.**

# Definition and Consequences

Arterial hypertension - chronic increase of the systemic blood pressure.

Symptoms indistinctive and nonspecific in the first stages of hypertension → almost 50% of the hypertensive patients do not know about their hypertension!

If not diagnosed in time and adequately treated, arterial hypertension results in:

- ❖ **overload of the left ventricle (hypertrophy, heart failure)**

- ❖ **arteriosclerosis**

  - increased risk of the myocardial infarction

  - increased risk of the stroke

  - the renal failure, etc.

**Hypertension significantly shortens the life span.**

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**Table 1** Definitions and classification of blood pressure (BP) levels (mmHg)

Category	Systolic		Diastolic
Optimal	< 120	and	< 80
Normal	120–129	and/or	80–84
High normal	130–139	and/or	85–89
Grade 1 hypertension	140–159	and/or	90–99
Grade 2 hypertension	160–179	and/or	100–109
Grade 3 hypertension	≥ 180	and/or	≥ 110
Isolated systolic hypertension	≥ 140	and	< 90

Methods of blood pressure measurement

Proper way of blood pressure measurement

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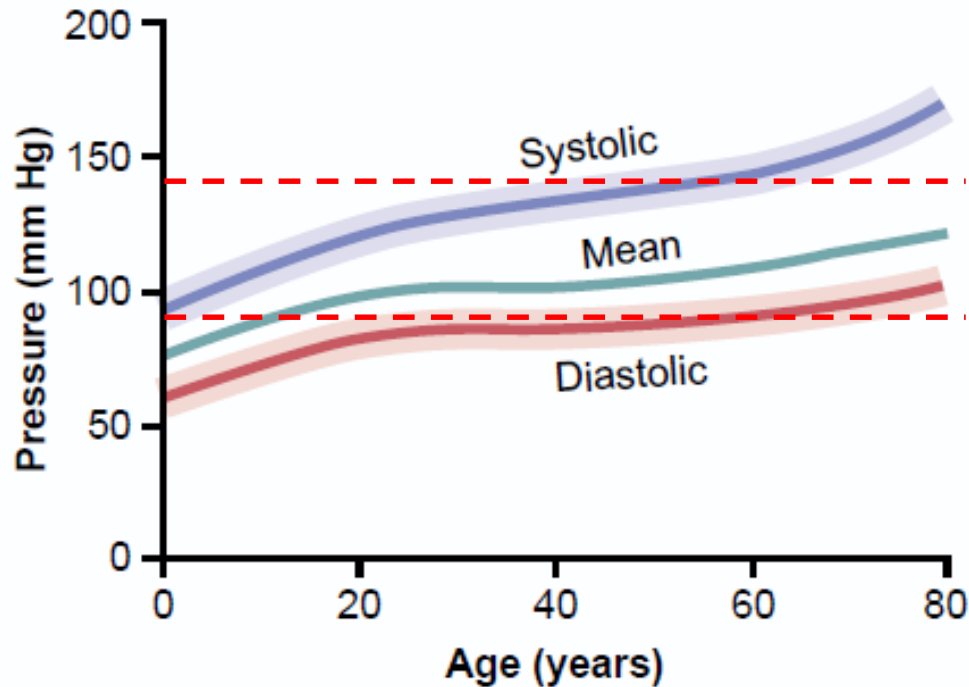
# Definition and Consequences

## Stratification of cardiovascular risk

Blood pressure (mmHg)					
Other risk factors, OD or Disease	Normal SBP 120–129 or DBP 80–84	High normal SBP 130–139 or DBP 85–89	Grade 1 HT SBP 140–159 or DBP 90–99	Grade 2 HT SBP 160–179 or DBP 100–109	Grade 3 HT SBP ≥180 or DBP ≥110
No other risk factors	Average risk	Average risk	Low added risk	Moderate added risk	High added risk
1–2 risk factors	Low added risk	Low added risk	Moderate added risk	Moderate added risk	Very high added risk
3 or more risk factors, MS, OD or Diabetes	Moderate added risk	High added risk	High added risk	High added risk	Very high added risk
Established CV or renal disease	Very high added risk	Very high added risk	Very high added risk	Very high added risk	Very high added risk



# Definition and Consequences



Guyton and Hall.  
Textbook of Medical Physiology, 11<sup>th</sup> edition

in children and adolescents – special percentile tables

# Factors Determining Blood Pressure

Ohm's law

$$U = I \cdot R$$



$$P = CO \cdot TPR$$

❖ ↑ cardiac output



→ volume-loading (hyperdynamic, volume dependent) h.

❖ ↑ total peripheral resistance

→ resistance (non-volume dependent) h.

# Factors Determining Blood Pressure

Ohm's law

$$U = I \cdot R \longrightarrow$$

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- ❖  $\uparrow$  cardiac output  $\uparrow$   
 $\longrightarrow$  volume-loading (hyperdynamic, volume dependent) h.
- ❖  $\uparrow$  total peripheral resistance  
 $\longrightarrow$  resistance (non-volume dependent) h.

$$C = \Delta V / \Delta P$$

- ❖  $\downarrow$  compliance  $\longrightarrow$  isolated systolic hypertension

heart

$$CO = SV \cdot HR$$

HR is guided by sympathetic and parasympathetic system

SV depends on:

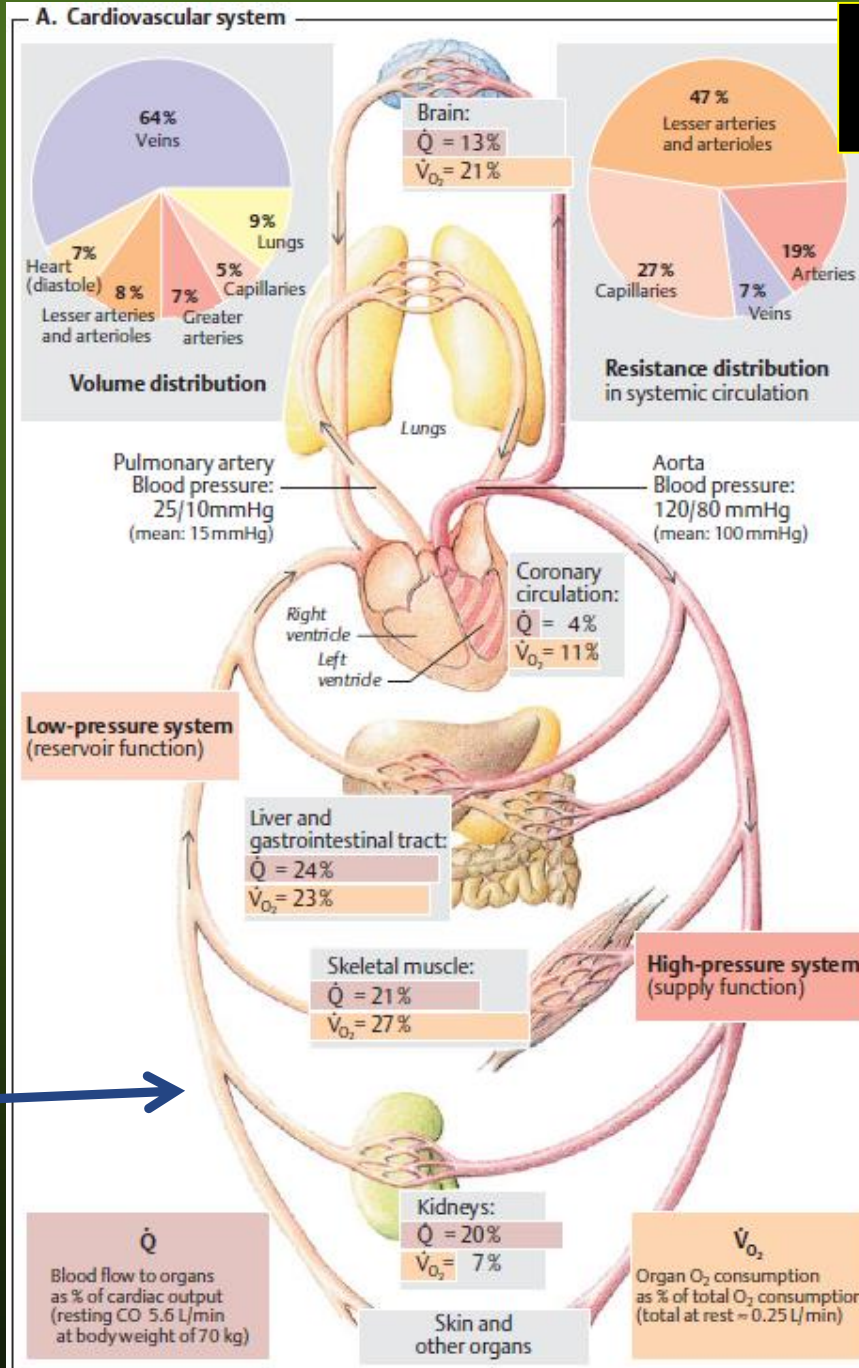
1. venous return (blood volume, tonus of veins)
2. contractility
3. peripheral pressure

veins

blood reservoir



$$P = CO \cdot TPR$$



kidneys  
regulation of  
blood volume

heart

$$CO = SV \cdot HR$$

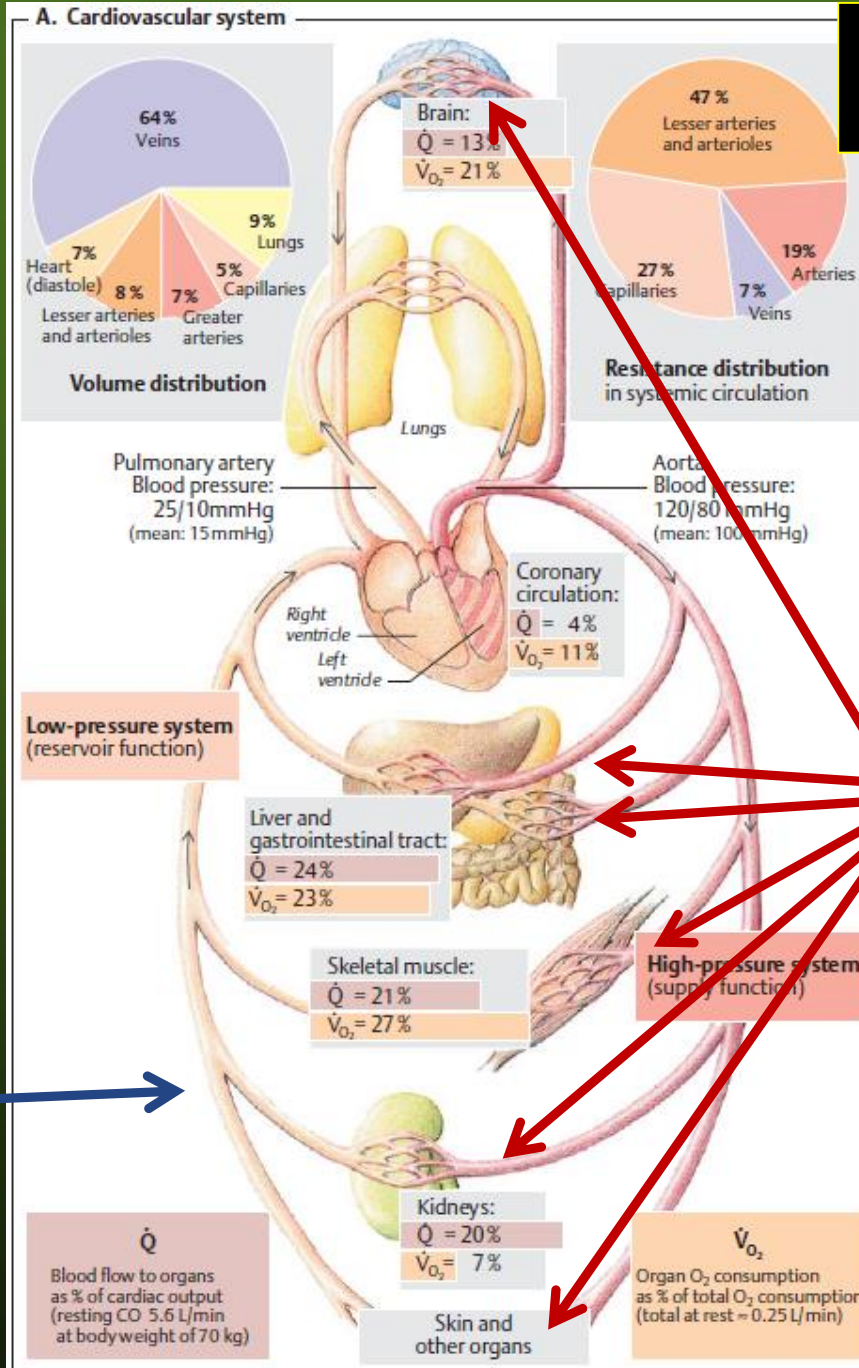
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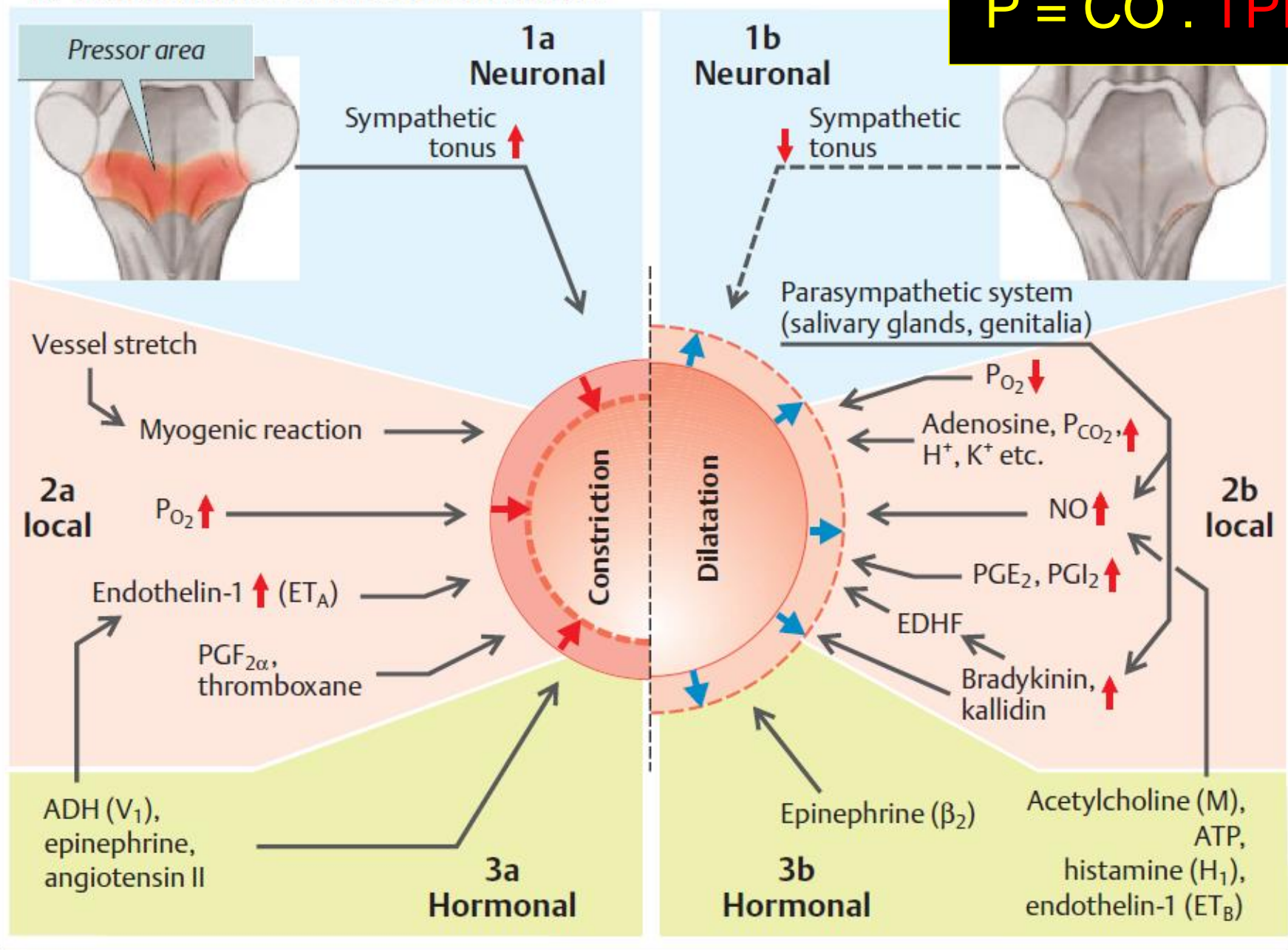
$$P = CO \cdot TPR$$

arterioles  
regulation of TPR

kidneys  
regulation of blood volume  
also TPR (RAS)

## B. Vasoconstriction and vasodilatation

$$P = CO \cdot TPR$$



heart

$$CO = SV \cdot HR$$

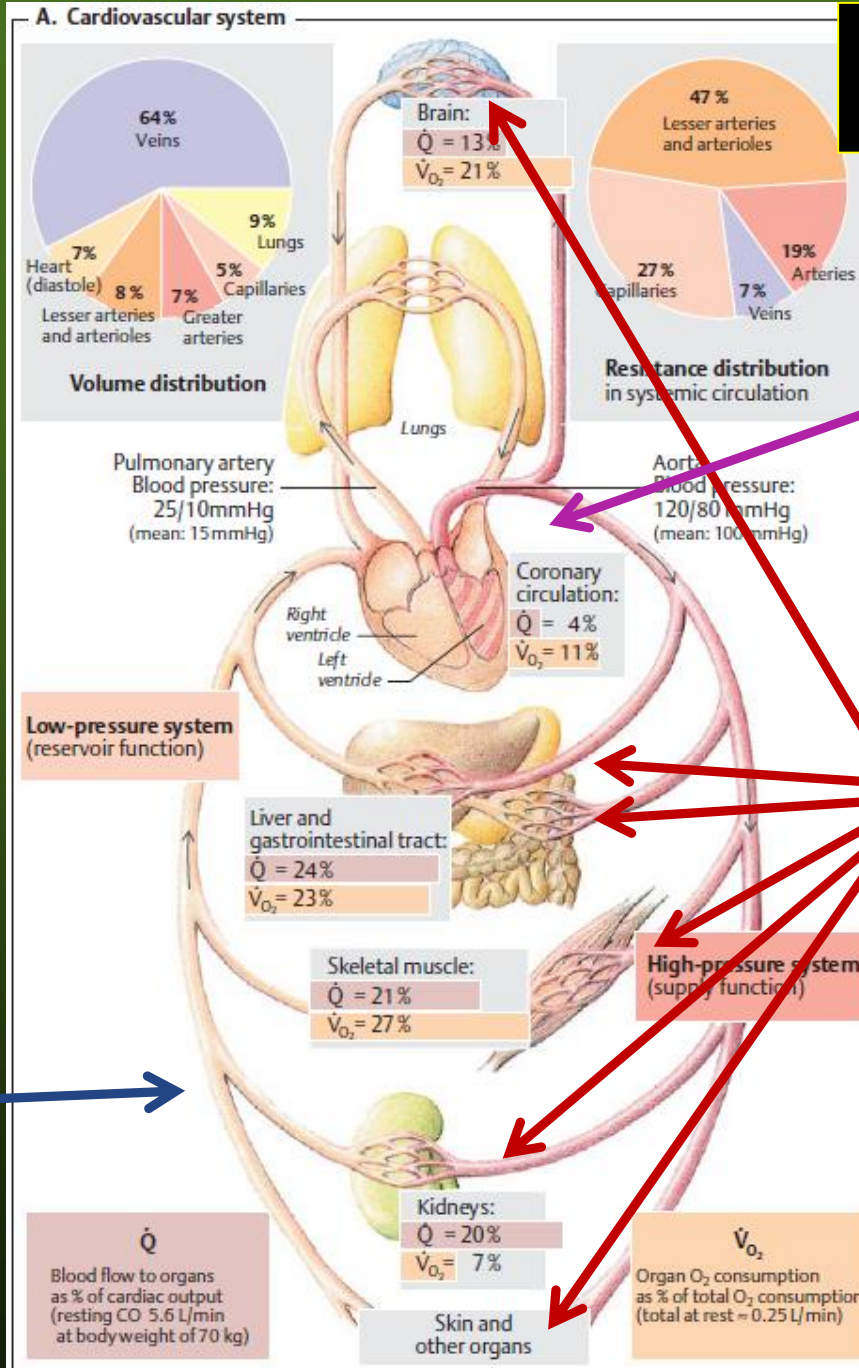
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SV depends on:

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$$P = CO \cdot TPR$$

aorta and big elastic arteries compliance

arterioles regulation of TPR

kidneys regulation of blood volume, also TPR (RAS)

heart

$$CO = SV \cdot HR$$

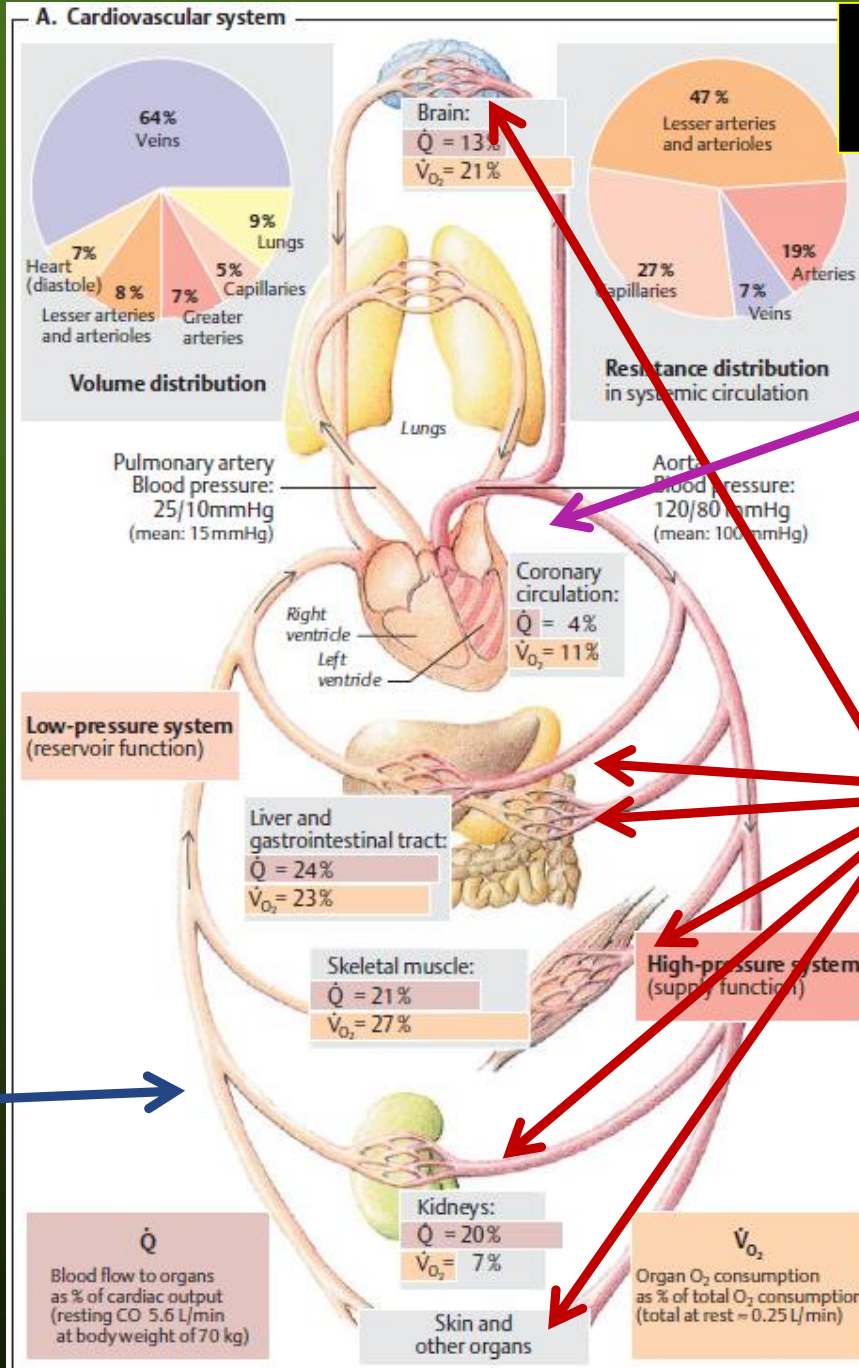
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$$P = CO \cdot TPR$$

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arterioles regulation of TPR

regulation of blood volume:

- kidneys
- thirst
- ADH



heart

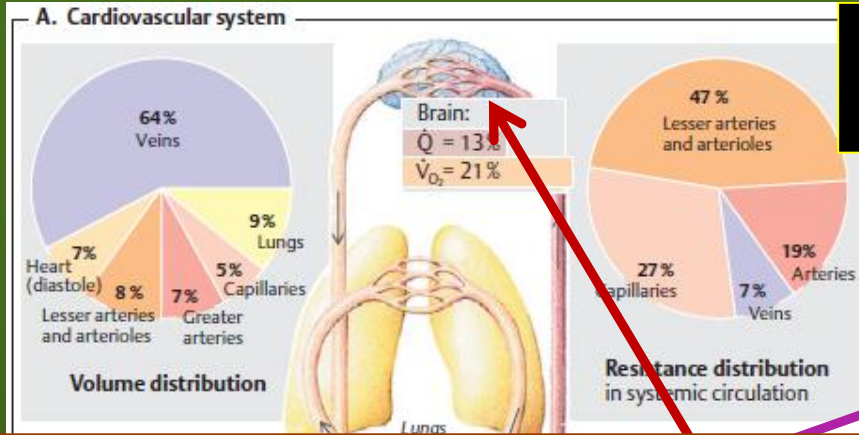
$$CO = SV \cdot HR$$

HR is guided by sympathetic and parasympathetic system

sv  
1.5  
(b  
to

$$P = CO \cdot TPR$$

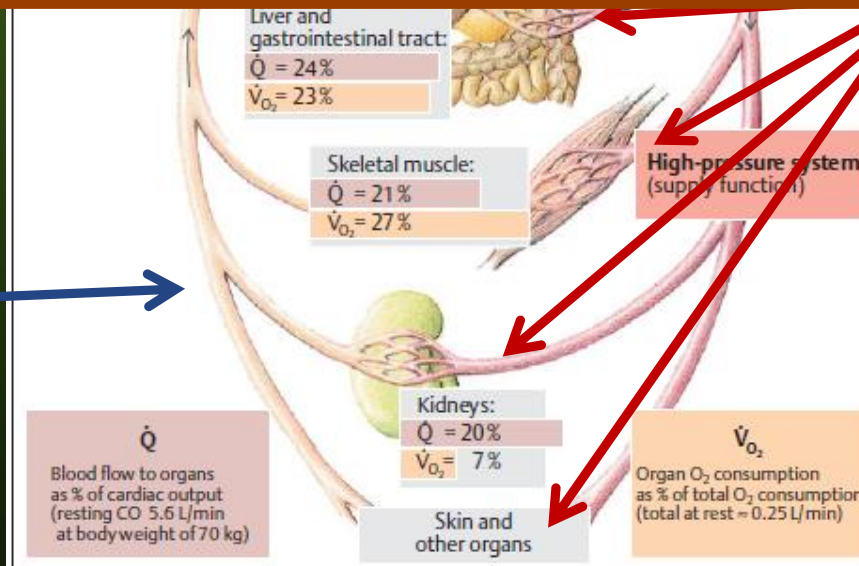
aorta and big elastic arteries



Pathophysiology of hypertension is very complex, thus, usually hard to be analyzed in a concrete patient!

3. peripheral pressure

veins  
blood reservoir



regulation of TPR

regulation of blood volume:

- kidneys
- thirst
- ADH

# Classification

## A. Essential (primary) hypertension

- „hypertension of an unknown origin“
- 90 – 95%

## B. Secondary (symptomatic) hypertension

- symptom of another primary disease with identifiable cause

# Essential Hypertension

- ❖ strong hereditary tendency in some patients (polygenic ground)
- ❖ provoking factors:
  - **excess weight gain, obesity** – account for about **65-70%** of the risk for developing of essential hypertension
  - **sedentary lifestyle**

*New clinical guidelines recommend increased physical activity and weight loss as the first step in treating most patients with the essential hypertension.*

- **stress** (namely mental)
- **excessive sodium intake** (interpopulation studies – Eskimos vs. people living in the North Japan)

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# Essential Hypertension

## Isolated Systolic Hypertension

- ❖ ↑ systolic and pulse pressure
- ❖ in the elderly
- ❖ due to:
  - **age-dependent remodelling of the wall of elastic arteries**  
(less elastic and more collagen fibres)
    - ↑ **stiffness**, ~↓ **compliance**:
      1. → ↓ **distension of elastic arteries during the systole**  
→ steeply ↑ arterial systolic pressure + ↓ blood volume  
(and also pressure) in arteries during the diastole
      2. → ↑ **pulse wave velocity**
  - **endothelial dysfunction**

# Essential Hypertension

## Treatment

*New clinical guidelines recommend **increased physical activity and weight loss** as the first step in treating most patients with EH.*

*Decrease of sodium and increase of potassium intake, relaxation ...*

### ❖ vasodilatory drugs

$$P = CO \cdot TPR$$

- $\downarrow$  TPR, some of them  $\uparrow$  renal blood flow as well (ACEI)
  - a. by inhibiting sympathetic nervous system (sympatolytics)
  - b. by directly paralyzing the smooth muscle of the renal vasculature (vasodilatory agents or calcium channel blockers)
  - c. by blocking action of the renin-angiotensin system on the renal blood vessels or tubules (inhibitors of angiotensin I-converting enzyme, ACEI)

### ❖ natriuretic (diuretic) drugs

- $\downarrow$  renal tubular reabsorption of salt and water  $\rightarrow$   $\downarrow$  CO  
(by blocking the active transport of sodium through the tubular wall)

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# Secondary Hypertension

## 1. Renal hypertension

- Prerenal causes - Renovascular hypertension
- Acute and chronic diseases of the renal parenchyma
- Postrenal causes (renal vein thrombosis, urinary tract obstruction)
- Renin-producing renal tumor

## 2. Endocrine hypertension

- Adrenocortical hyperfunction (Cushing's, Conn's, adrenogenital sy)
- Sympatoadrenal hyperfunction (pheochromocytoma)
- Exogenic hormones (gluko-, mineralocorticoids, sympatomimetics)
- Hyperthyroidism
- Acromegaly

## 3. Coarctation of the aorta

## 4. Hypertension in preeklampsia

## 5. Neurogenic hypertension