HYPERTENSION

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Reference: Robbins & Cotran Pathology and Rubin's Pathology

LECTURE OUTLINE

- Definition and risk factors
- Classification
  - Primary & secondary HTN
  - Causes of secondary HTN
  - Benign vs malignant HTN
- Pathogenesis
- Regulation of blood pressure
- Vascular morphology in HTN
- Heart in HTN
- Complications of HTN

HYPERTENSION AND HYPERTENSIVE VASCULAR DISEASE

- Common problem (25% of population)
- Asymptomatic until late- Silent Killer – painless –.
- Complications alert to diagnosis but late…
- **Hypertension:** *Definition:* a sustained diastolic pressure more than 90 mm Hg or a sustained systolic pressure in excess of 140 mm Hg (>140/90)
- In the early stages of HTN there are few or no symptoms.
- Hypertension is an important factor which contributes in development of:
  - Coronary heart disease.
  - Cerebrovascular accidents (stroke)
  - Cardiac hypertrophy
  - Congestive heart failure.
  - Aortic dissection.
  - Renal failure.
  - Retinopathy

RISK FACTORS FOR HYPERTENSION

- **Hereditary,**Genetics- family history
- **Race.** African-Americans
- **Gender.** Men & postmenopausal women
- **Age**
- **Obesity**
- **Diet, particularly sodium intake**
- **Lifestyle-stressful**
- **Heavy alcohol consumption**
- **Diabetes**
- **Use of oral contraceptives**
- **Sedentary or inactive lifestyle**

CLASSIFICATION: BASED ON ETIOLOGY/CAUSE

I. **Primary/Essential Hypertension (95%) :** Mechanisms largely unknown. It is idiopathic.

II. **Secondary Hypertension (5-10%):** it can be due to pathology in the renal, endocrine, vascular or neurogenic systems

CAUSES OF SECONDARY HYPERTENSION

Renal	**Glomerulonephritis,** **Renal artery stenosis,** **Renal vasculitis** **Adult polycystic disease** **Chronic renal disease,** **Renin producing tumors**
Endocrine	**Adrenocortical hyperfunction (Cushing syndrome, primary aldosteronism, congenital adrenal hyperplasia)** **Hyperthyroidism/Thyrotoxicosis** **Hypothyroidism/Myxdema,** **Pheochromocytoma** **Acromegaly** **Exogenous hormones (glucocorticoids, estrogen e.g. oral contraceptives)** **Pregnancy-induced**
Vascular	**Coarctation of aorta** **Vasculitis e.g.Polyarteritis nodosa** **Increased intravascular volume** **Increased cardiac output** **Rigidity of the aorta**
Neurogenic	**Psychogenic** **Increased intracranial pressure** **Sleep apnea** **Acute stress, including surgery**

CLASSIFICATION BASED ON CLINICAL FEATURES.

- **Benign:**
  - The BP is at modest level (not very high).
  - it can be idiopathic HTN or secondary HTN
  - Fairly stable over years to decades.
  - Compatible with long life.

- **Malignant(5%):**
  - there is rapidly rising BP which often leads to end organ damage
  - It can be a complication any type of HTN (i.e. essential or secondary)
  - It is seen in 5% of HTNsive patients.
  - The diastolic pressure is usually over 120mmHg
  - It is associated with:
    - Widespread arterial necrosis and thrombosis
    - Rapid development of renal failure
    - Retinal hemorrhage and exudate, with/without papilledema
    - Hypertensive encephalopathy
    - Left ventricular failure
    - Leads to death in 1 or 2 years if untreated.

REGULATION OF BLOOD PRESSURE (BP)

Two hemodynamic variables are involved in the regulation of BP: cardiac output and peripheral vascular resistance

BP = Cardiac Output x Peripheral Resistance

- **Cardiac output** is affected by blood volume and is dependent on sodium concentrations.
- **Peripheral resistance** is regulated predominantly at the level of the arterioles (also known as resistance vessels) and is influenced by neural and hormonal inputs. Normal BP is maintained by a balance between factors that induce vasoconstriction (e.g., angiotensin II and catecholamines) and factors that induce vasodilation (e.g., kinins, prostaglandins, and nitric oxide). An increased blood flow in the arterioles induces vasoconstriction to protect tissues against hyperperfusion.

PATHOGENESIS OF ESSENTIAL HYPERTENSION

Essential HTN occurs when the relationship between cardiac output and peripheral resistance is altered. Multiple **genetic and environmental factors** ultimately **increase the cardiac output and/or peripheral resistance (BP = Cardiac Output x Peripheral Resistance)**

1. ***Genetic factors:*** There is a strong genetic component (family history). A genetic effect is involved in making people more susceptible or less susceptible to high salt diet etc.
   a) Defect in renal sodium homeostasis: r*educed renal sodium excretion* is a key initiating event in most forms of essential hypertension. This decreased sodium excretion will result in increase in fluid volume and therefore increase in cardiac output, thereby elevating blood pressure. This is usually due to defect in cell membrane function: affecting Na/Ca transport.
   b) Functional vasoconstriction: abnormality in vascular tone such as increased sympathetic stimulation will cause vasoconstriction leading to increased peripheral resistance.
   c) Structural abnormality in vascular smooth muscle also leads to increased peripheral resistance.

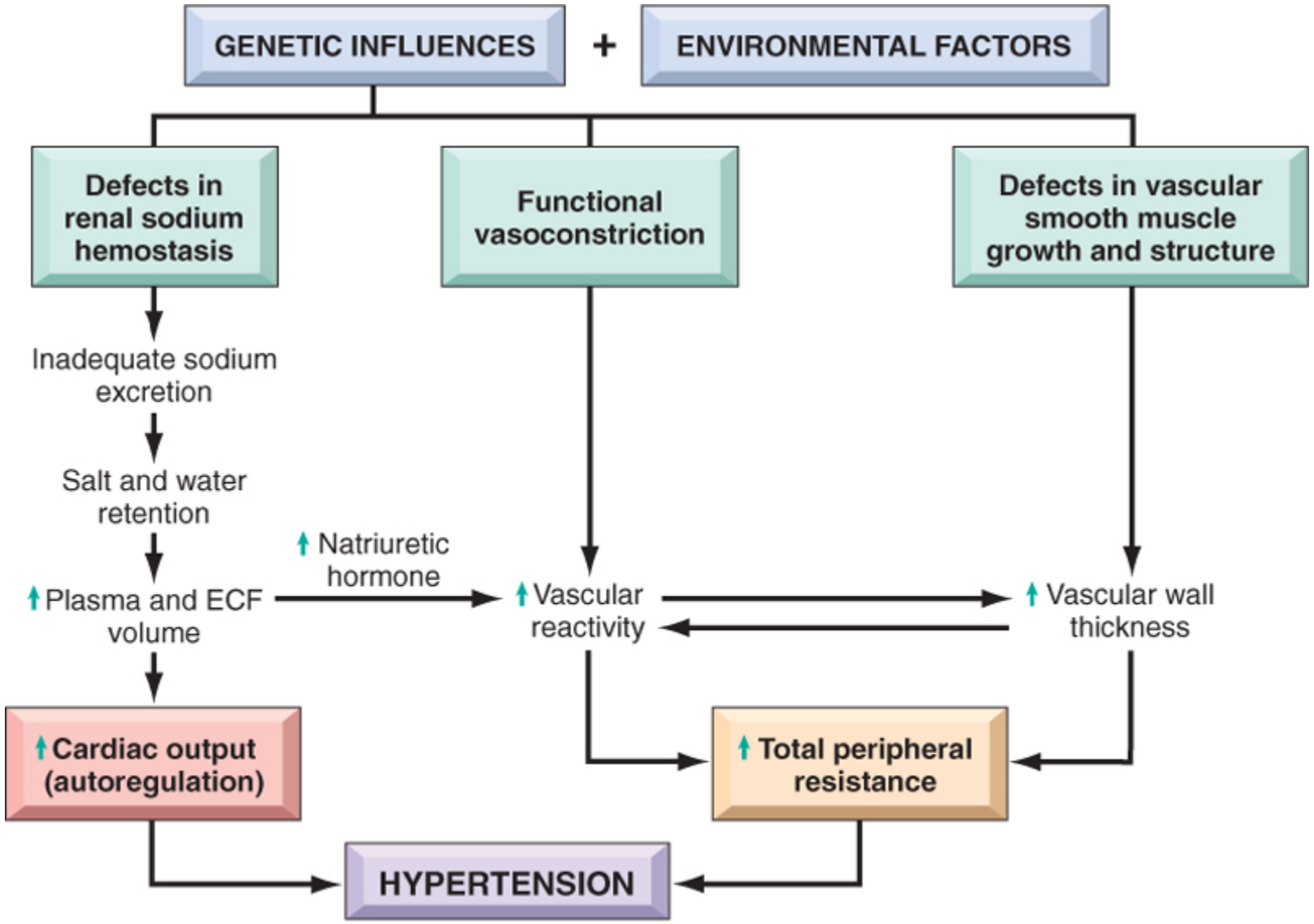
PATHOGENESIS OF ESSENTIAL HYPERTENSION

d) Also rare gene disorders can cause HTN by increasing renal sodium resorption e.g. Liddle syndrome. Liddle syndrome is an inherited autosomal dominant type of HTN, that begins in childhood. It is caused by mutations of the epithelial sodium channel protein (ENaC) which leads to increased sodium reabsorption in the renal tubules (followed by water), which leads to hypertension. Reabsorption of sodium is also correlates with potassium loss (hypokalemia).

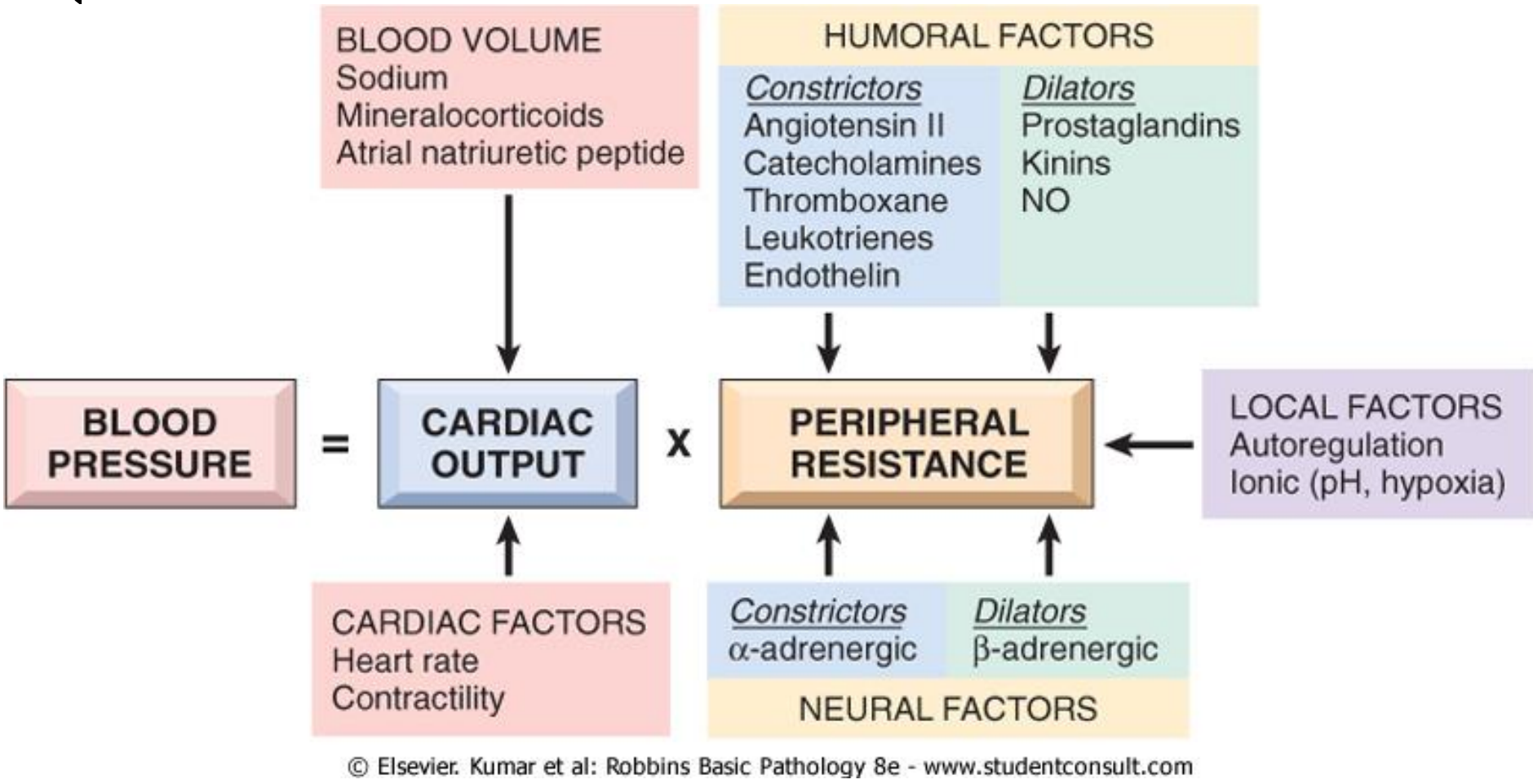
2. ***Environmental factors:*** stress, obesity, smoking, physical inactivity, and heavy consumption of salt also play a role.

NOTE: In hypertension, both increased blood volume and increased peripheral resistance contribute to the increased pressure. However reduced renal sodium excretion in the presence of normal arterial pressure (initially) is probably a key initiating event.

PATHOGENESIS OF ESSENTIAL HYPERTENSION

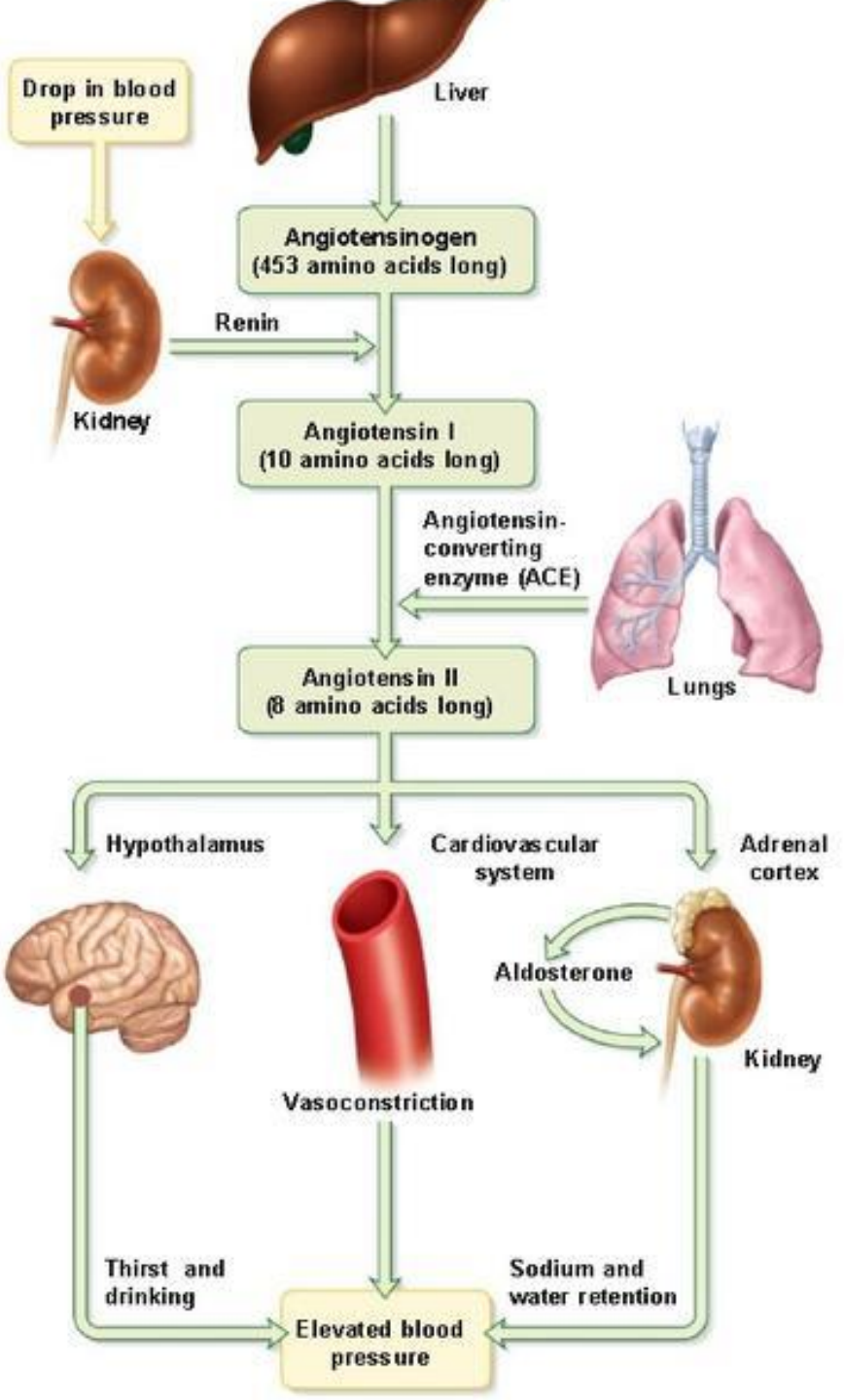


REGULATION OF BLOOD PRESSURE (BP



ENDOCRINE FACTORS: **Renin, Angiotensin, ADH, Aldosterone**

ENDOCRINE FACTORS: role of renin-angiotensin- aldosterone in regulating BP



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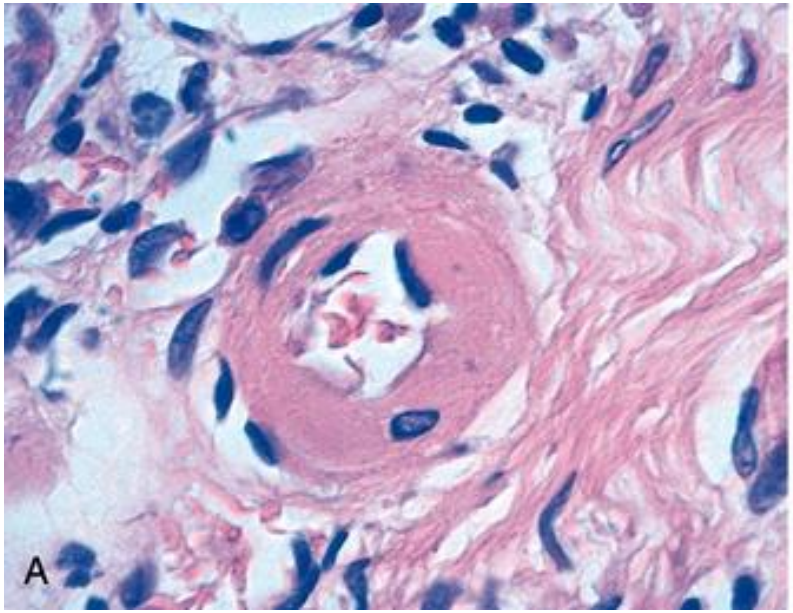
ATRIAL NATRIURETIC PEPTIDE / FACTOR / HORMONE (CARDIONATRINE / CARDIODILATINE / ATRIOPEPTIN)

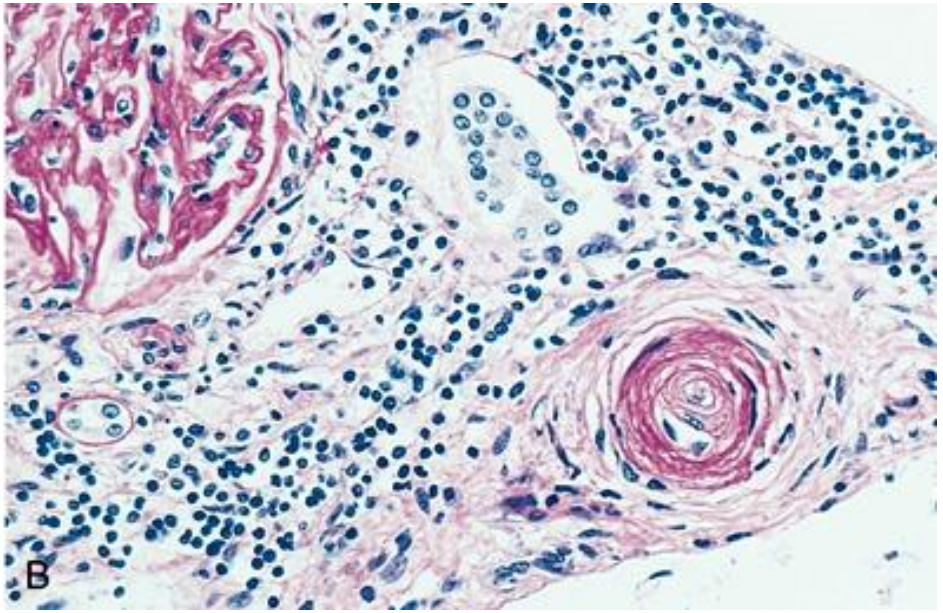
- It is a protein (polypeptide) hormone secreted by the heart muscle cells in the atria of heart (atrial myocytes).
- It is a powerful vasodilator and is involved in the homeostatic balance of body water, sodium, potassium and fat.
- It is released in response to high blood volume. It acts to reduce the water, sodium and adipose loads on the circulatory system, thereby reducing blood pressure.
- It has exactly the opposite function of the aldosterone secreted by the zona glomerulosa
- **In the kidney:**
  - decreases sodium reabsorption and increases water loss.
  - Inhibits renin secretion, thereby inhibiting the renin–angiotensin–aldosterone system
- **In adrenal gland:**
  - Reduces aldosterone secretion by the zona glomerulosa of the adrenal cortex.
- **In arterioles:**
  - Promotes vasodilatation
- **In adipose tissue**
  - Increases the release of free fatty acids from adipose tissue.

MORPHOLOGY OF BLOOD VESSELS IN HTN:

- In large Blood Vessels (Macroangiopathy)
  - Atherosclerosis. HTN is a major risk factor in AS.
- In small Blood Vessels (Microangiopathy)
  - Arteriolosclerosis
    1. Hyaline arteriolosclerosis:
       - Characteristic of benign hypertension
       - Can also be seen in elderly and diabetic patients even without hypertension.
       - Can cause diffuse renal ischemia which ultimately leads to benign nephrosclerosis
    2. Hyperplastic arteriolosclerosis:
       - Characteristic of malignant hypertension.
       - Can show onion-skinning on histology causing luminal obliteration of vascular lumen
       - May be associated with necrotizing arteriolitis and fibrinoid necrosis

VASCULAR PATHOLOGY IN HYPERTENSION.



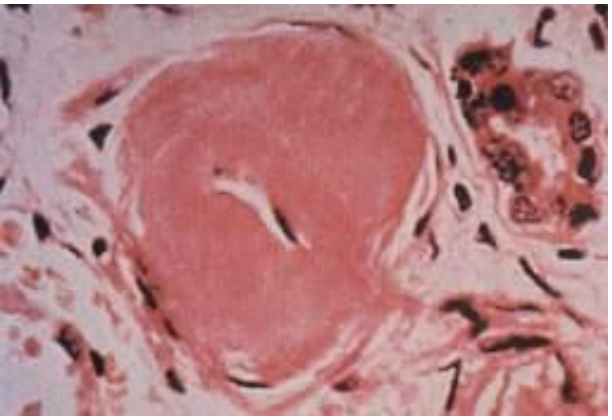


A. Hyaline arteriolosclerosis: hyalinosis of arteriolar wall with narrowing of lumen.

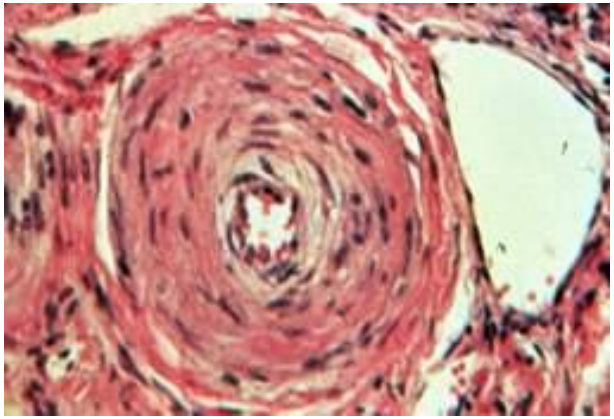
B. Hyperplastic arteriolosclerosis (onionskinning) causing luminal obliteration of vascular lumen

Vascular pathology in hypertension.
A. Hyaline arteriolosclerosis. The arteriolar wall is hyalinized and the lumen is markedly narrowed.
B. Hyperplastic arteriolosclerosis (onionskinning) causing luminal obliteration (arrow), with secondary ischemic changes, manifested by wrinkling of the glomerular capillary vessels at the upper left (periodic acid–Schiff [PAS] stain).

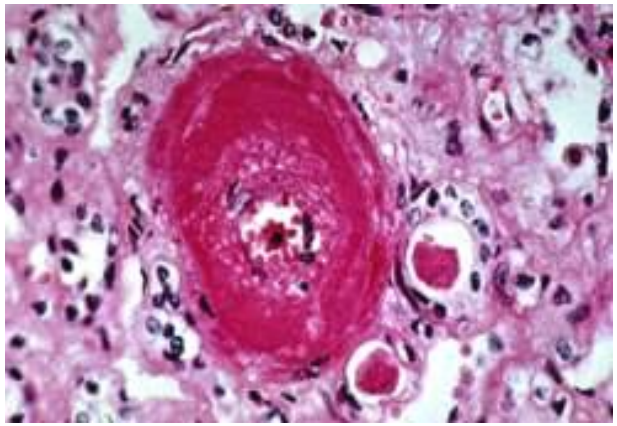
VASCULAR PATHOLOGY IN HYPERTENSION



Hyaline/ Benign hypertension



Hyperplastic/ Malignant hypertension

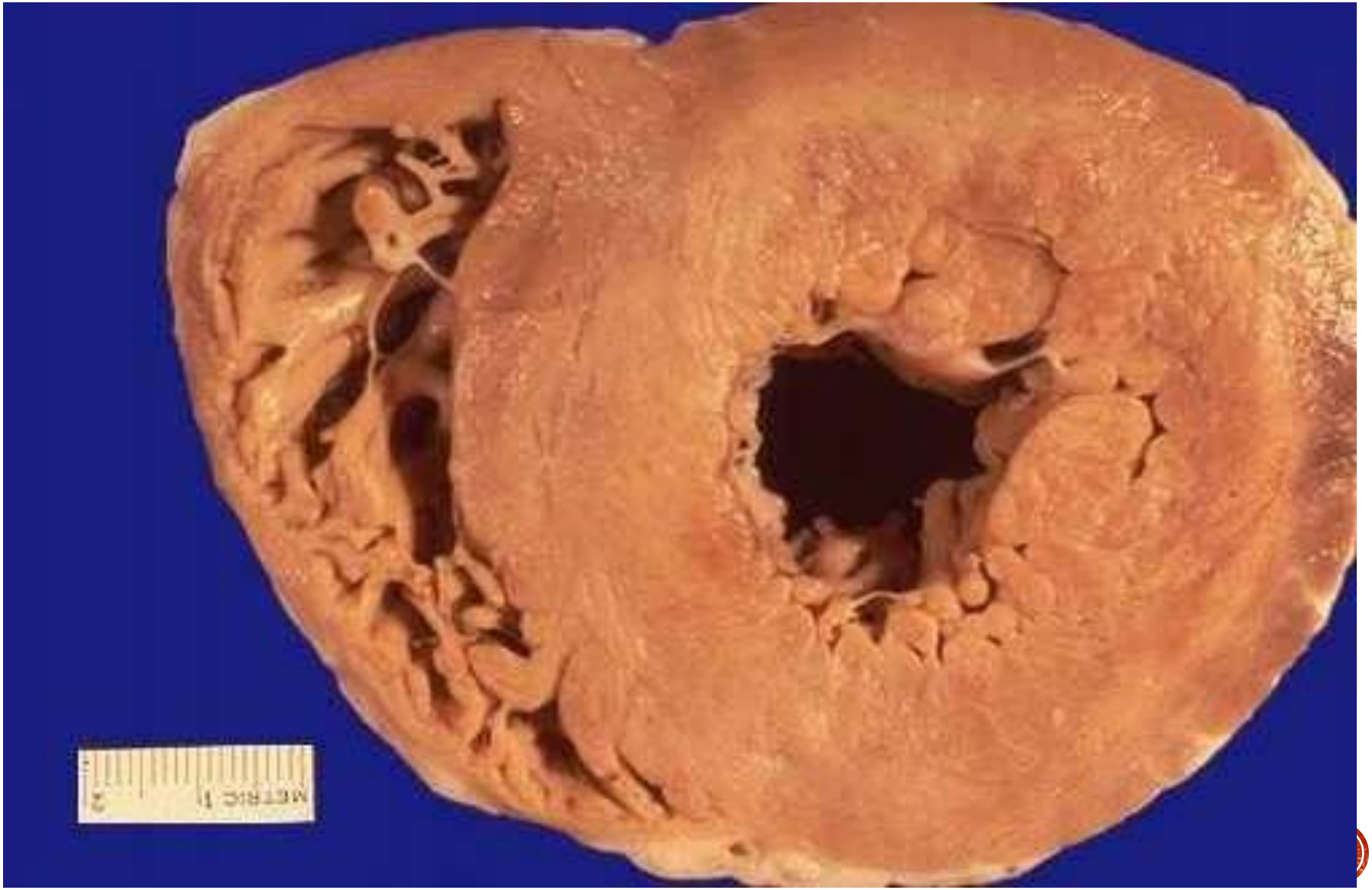


Hyperplastic/ Malignant hypertension

Left ventricular cardiac hypertrophy (left sided hypertensive cardiomyopathy/ hypertensive heart disease)

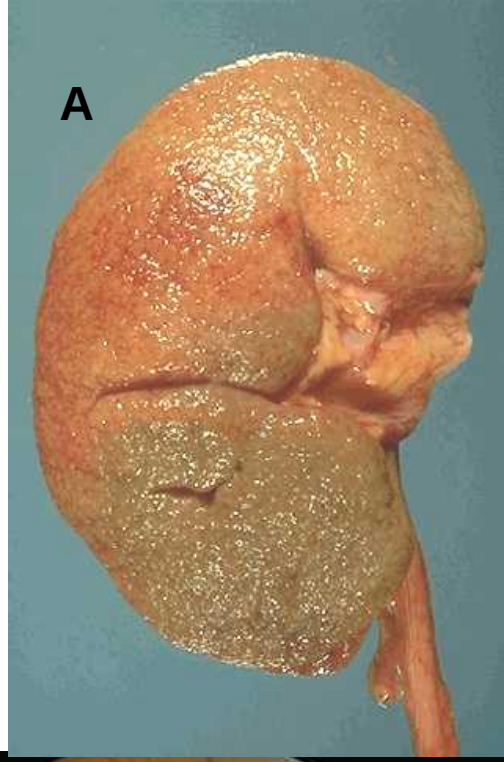
- Longstanding poorly treated HTN leads to left sided hypertensive heart disease.
- Hypertrophy of the heart is an adaptive response to pressure overload due to HTN. HTN induces left ventricular pressure overload which leads to hypertrophy of the left ventricle with increase in the weight of the heart and the thickness of the LV wall.

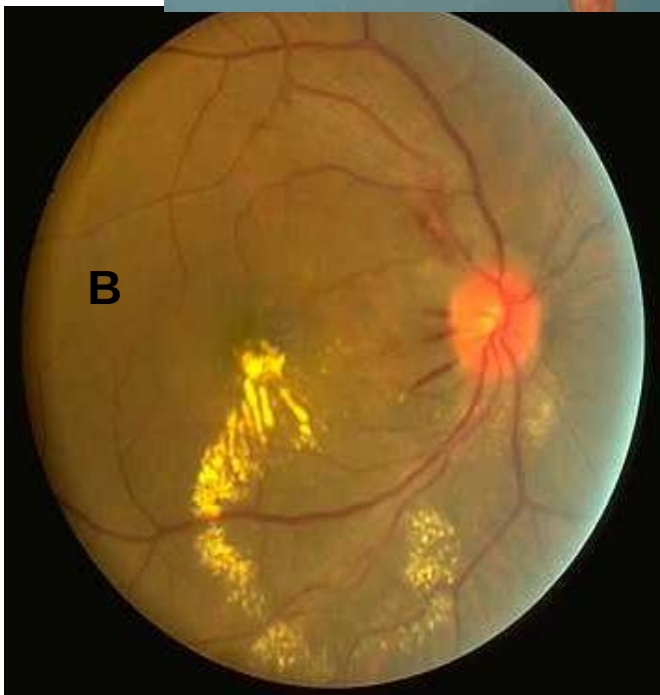
LEFT VENTRICULAR HYPERTROPHY



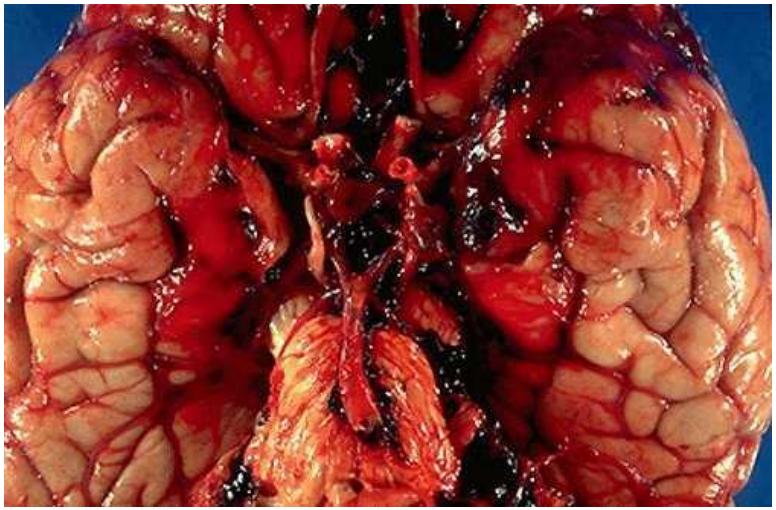
COMPLICATIONS/ORGAN DAMAGE IN HTN:

- Cardiovascular
  - Left ventricular cardiac hypertrophy(left sided hypertensive cardiomyopathy/ hypertensive heart disease)
  - Coronary heart disease
  - Aortic dissection
- Kidney
  - Benign nephrosclerosis (photo A)
  - Renal failure in untreated or in malignant hypertension
- Eyes
  - Hypertensive retinopathy (photo B) is especially seen in malignant hypertension.
- Brain
  - Haemorrhage, infarction leading to Cerebrovascular accidents

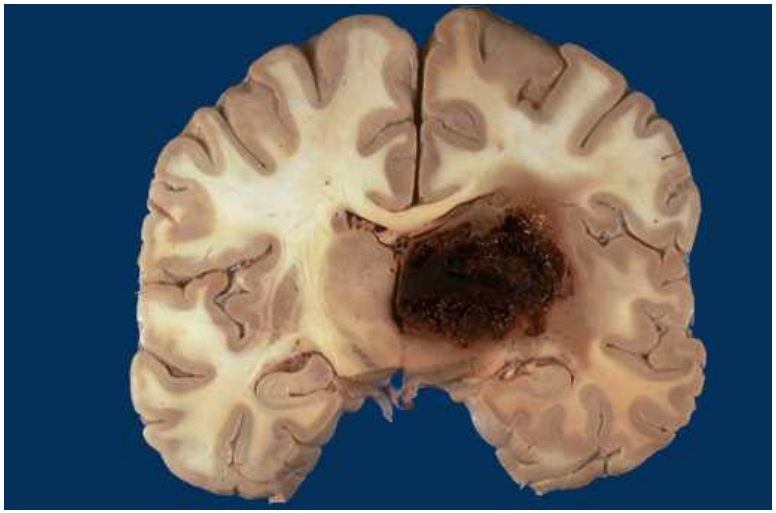




SUBARACHNOID HAEMORRHAGE

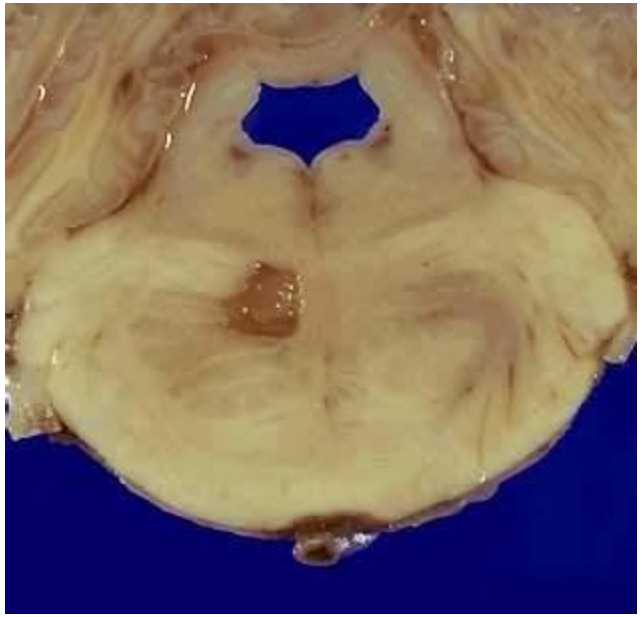


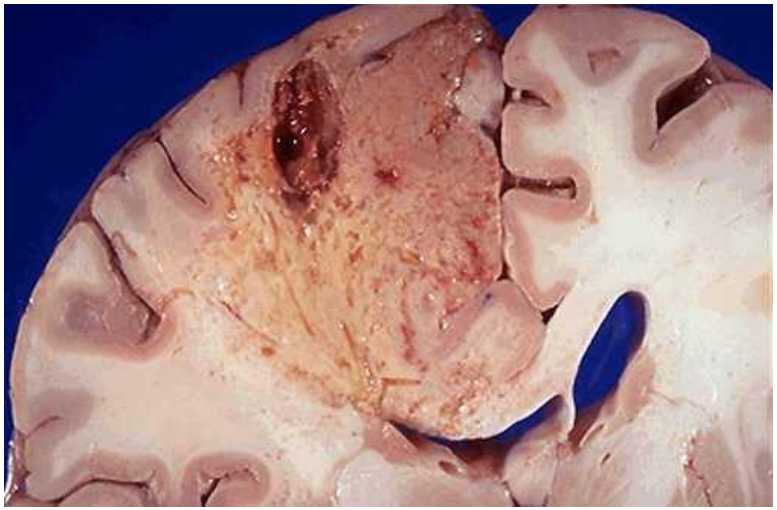
CEREBRAL HEMORRHAGE



Cerebral Infarction

Lacunar infarct



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