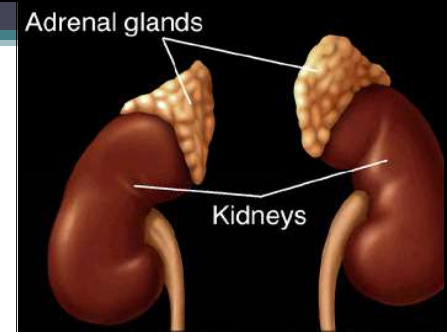


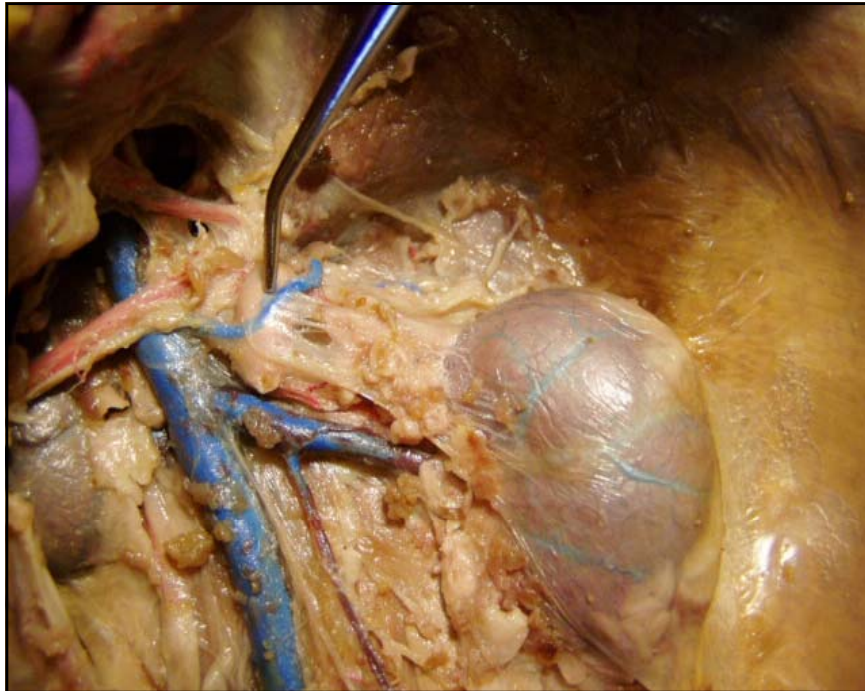
# ADRENAL GLAND

D.Hammoudi.MD

## Introduction

- Among most important and vital endocrine organ
- Small bilateral yellowish retroperitoneal organ
- Lies just above kidney in Gerota's fascia





## The Adrenal Gland

Anatomy was first described in 1563.

Is located above (or attached to) the upper pole of the kidney.

Is pyramidal in structure and weighs about 4-5 grams.

Consists of the adrenal cortex and adrenal medulla

Activities are regulation of fluid volume and stress response

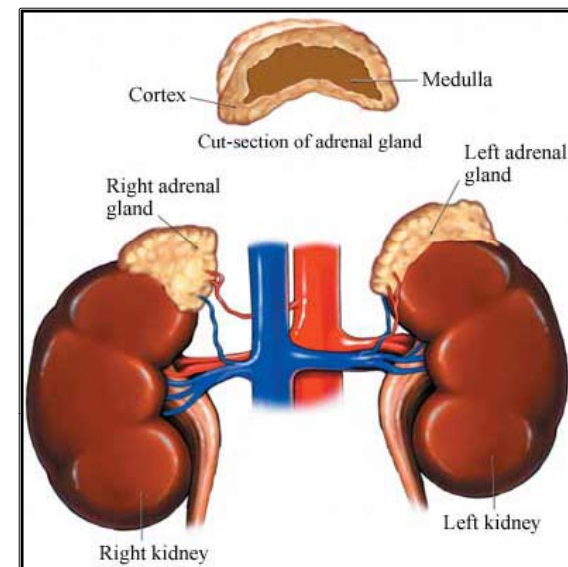
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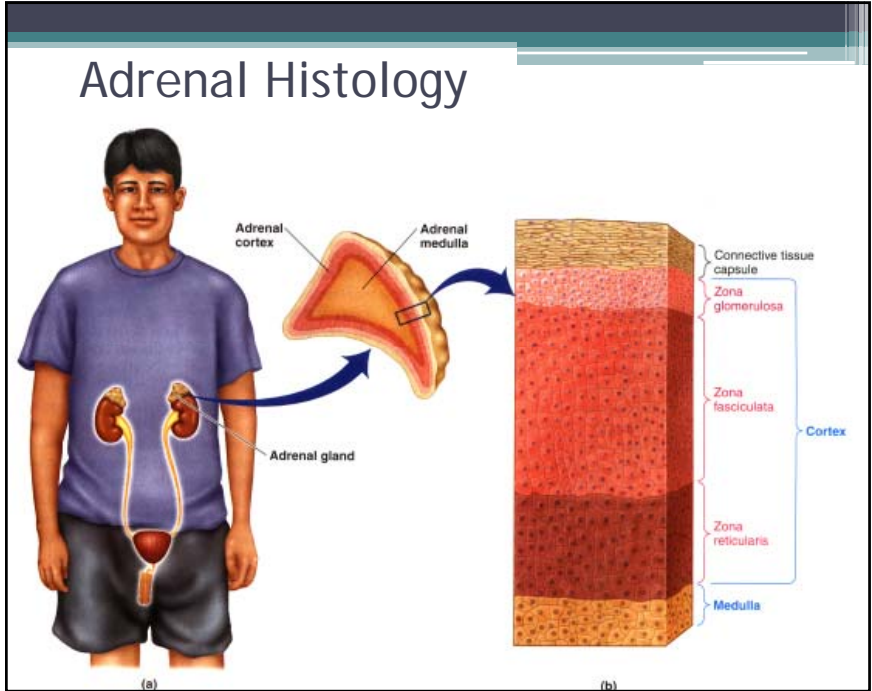
## Anatomy

- Right adrenal is triangular, related to upper pole Right kidney
- Left adrenal is crescent shaped, related to upper and medial part Left kidney
- Size : 3 - 6cm long, 0.9 – 3.6cm
- Weight : 3-5 gm app
- Width : 2-3 cm

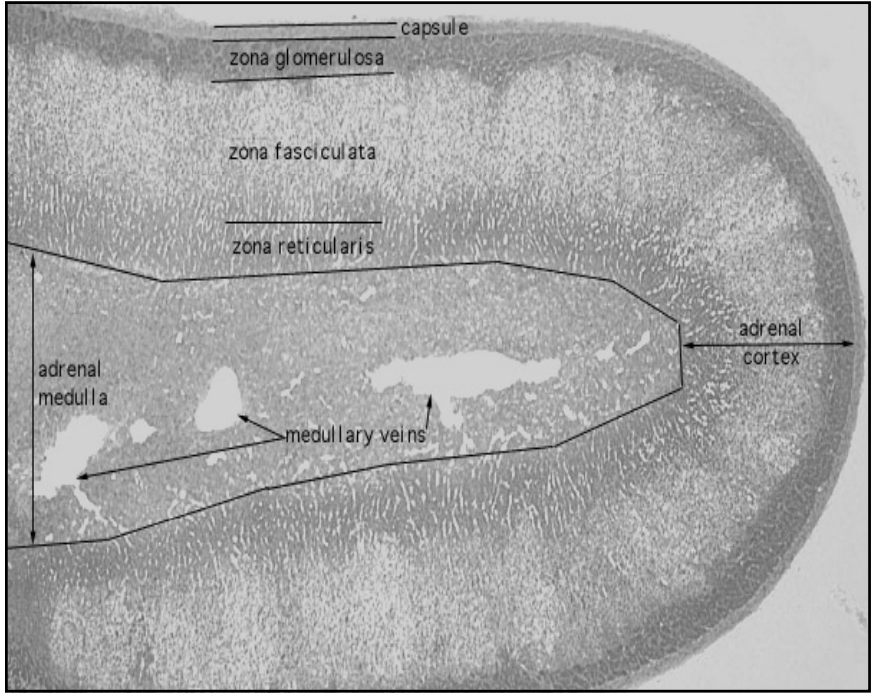
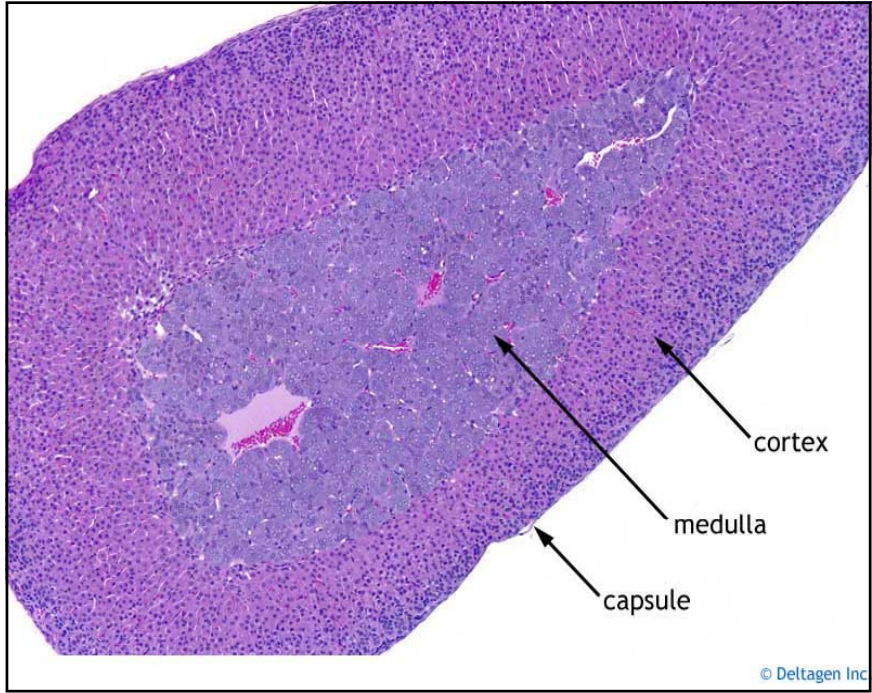
## Anatomy

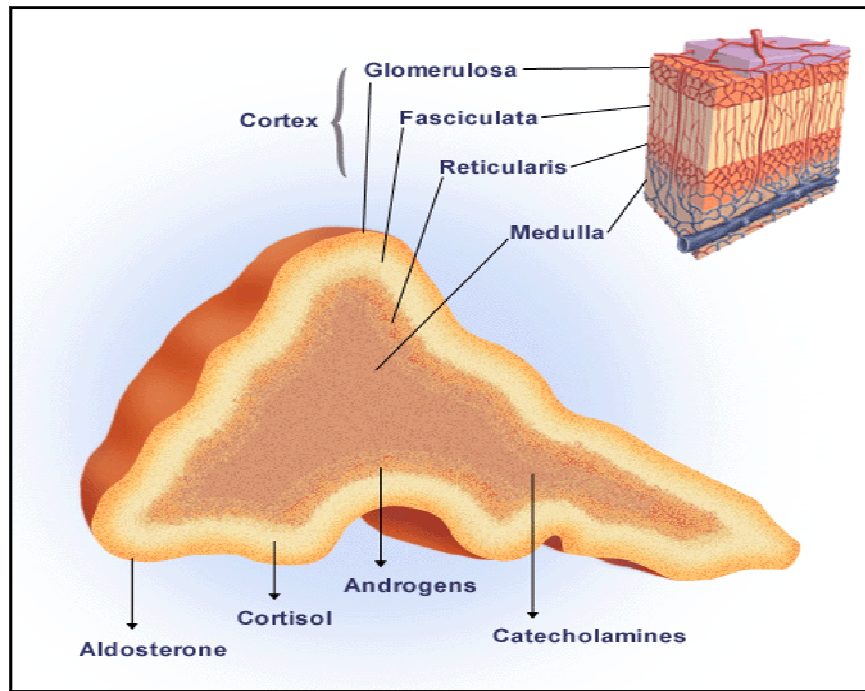
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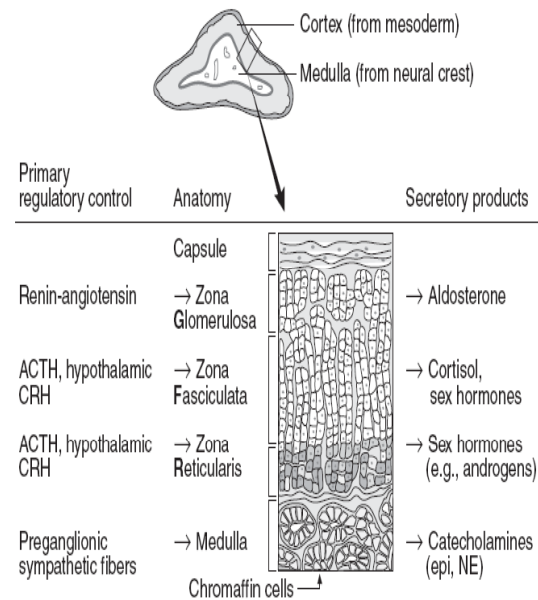
## Adrenal Cortex

- Is divided into 3 zones in the adult gland:
  - Zona Glomerulosa,
  - Zona Fasciculata,
  - Zona Reticularis.
- Is divided onto 4 zones in the fetal gland.
- The three zones of the permanent cortex constitutes only 20% of the fetal gland's size.
- The remaining zone (fetal cortex) comprises up to 80% of gland's size during fetal life.

## Adrenal Cortex: Steroid Hormone Production

- Aldosterone, sex hormones, cortisol
- Synthesized from cholesterol—steroid ring

### Adrenal cortex and medulla



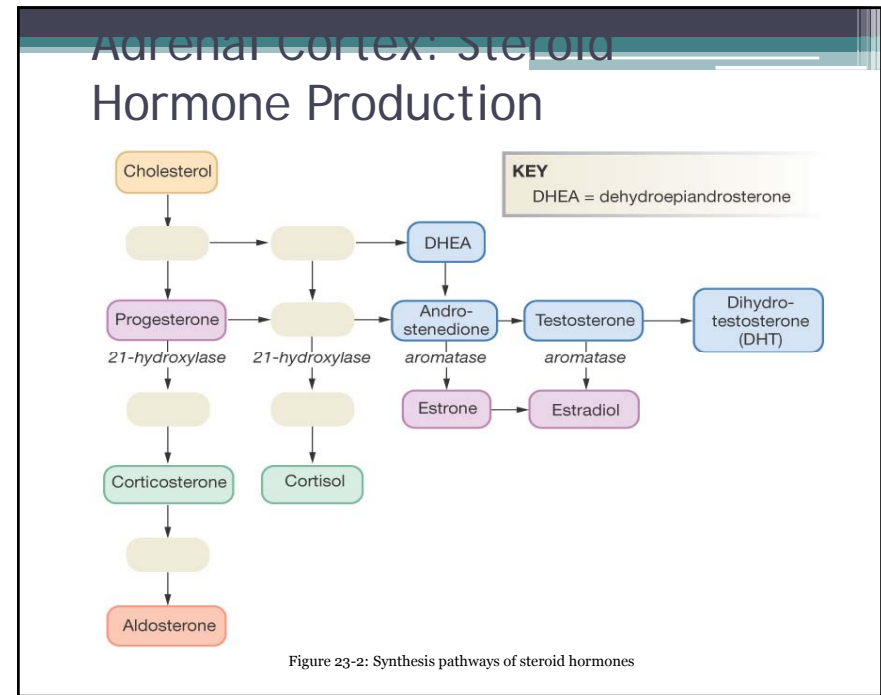
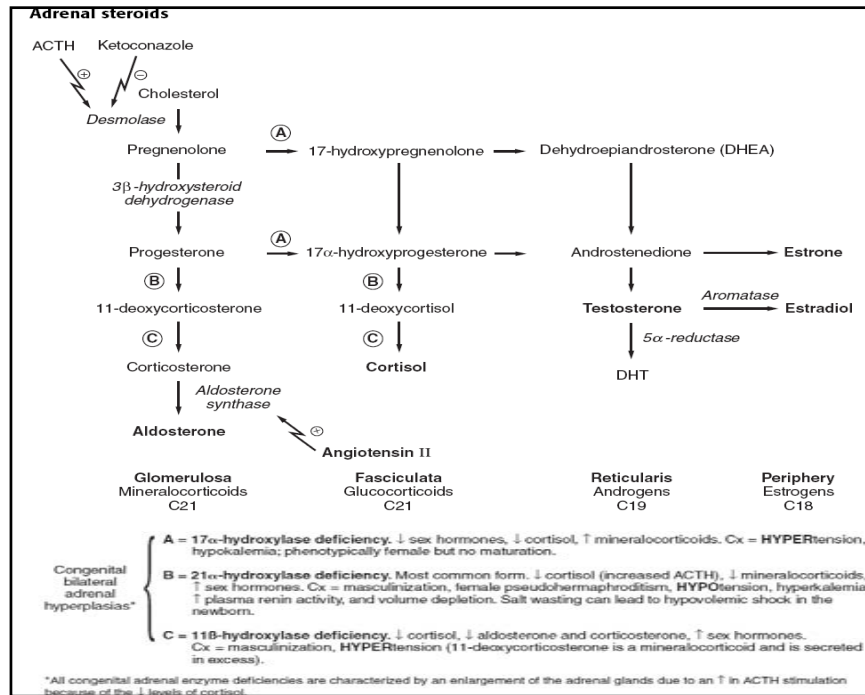
GFR corresponds with Salt ( $\text{Na}^+$ ), Sugar (glucocorticoids), and Sex (androgens).

“The deeper you go, the sweeter it gets.”

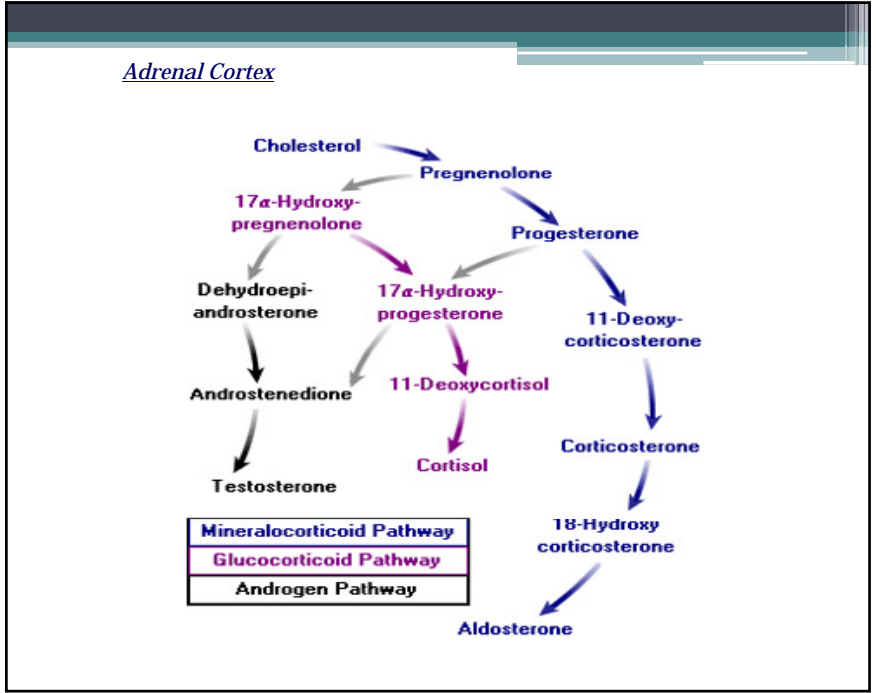
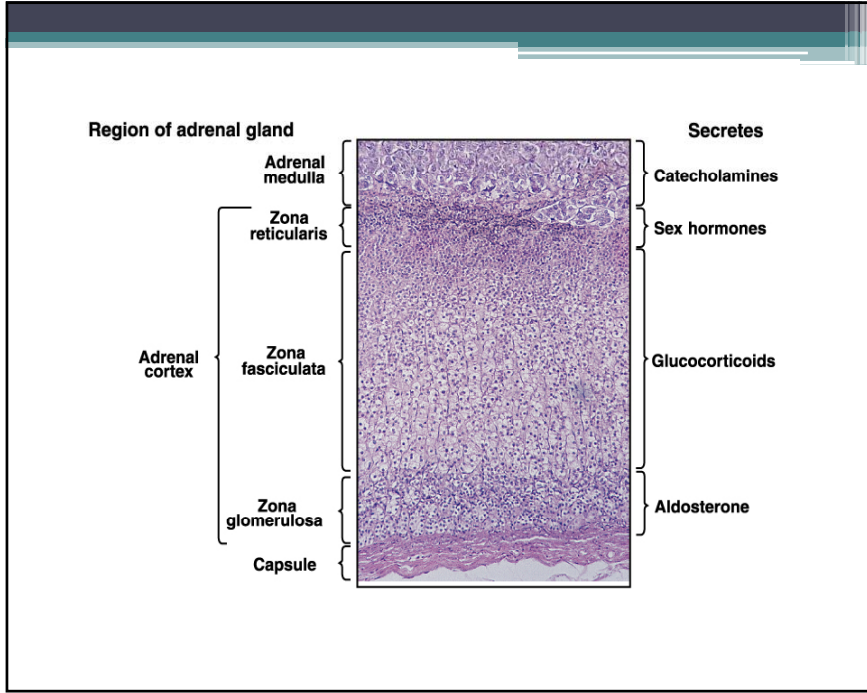
**Pheochromocytoma**—most common tumor of the adrenal medulla in adults.

**Neuroblastoma**—most common in children.

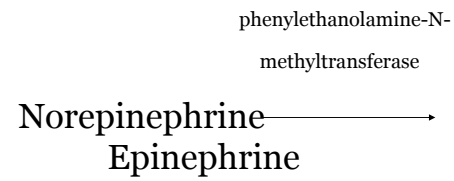
Pheochromocytoma causes episodic hypertension; neuroblastoma does not.







### Adrenal Medulla



### Physiology

- Adrenal cortex produces
  - Glucocorticoids (Zona Fasciculata)
  - Mineralocorticoids (Zona Glomerulosa)
  - Adrenal androgens (Zona Reticularis)

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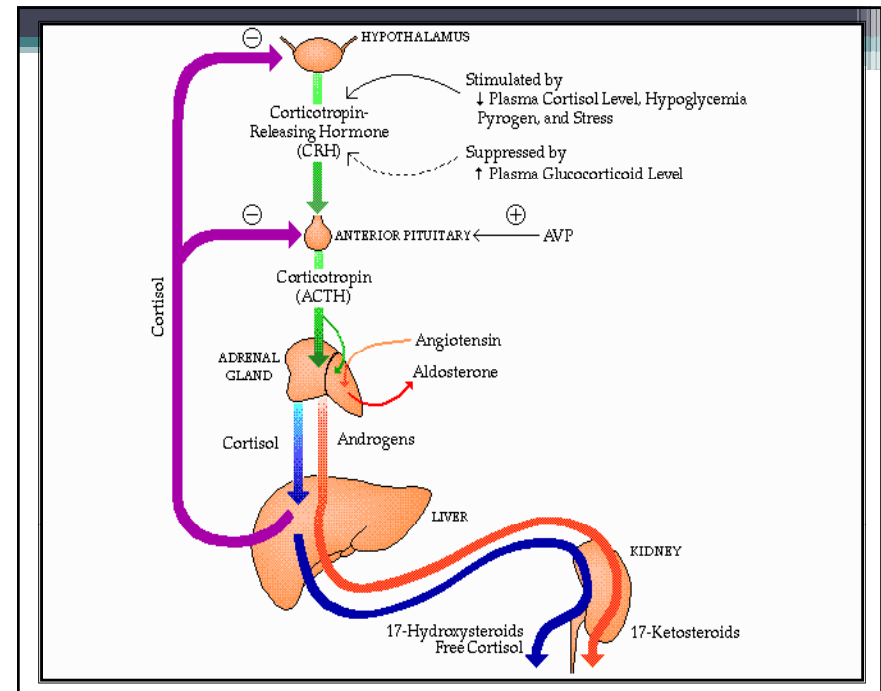
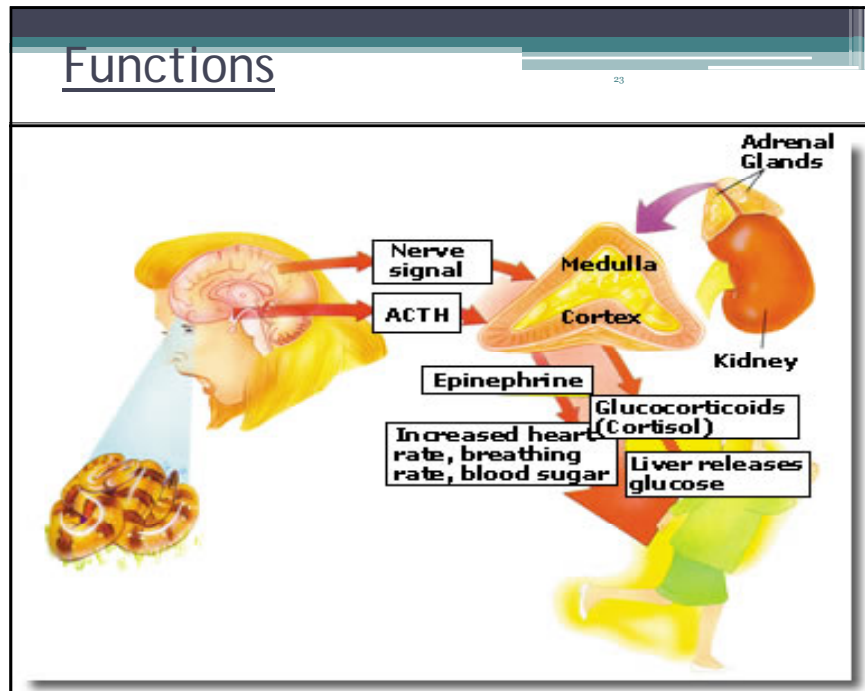
## Physiology

- Adrenal medulla produces
  - Epinephrine (adrenaline)
  - Norepinehrine (noradrenaline)
- Help inc in cardiac output, vascular resistance and mediate stress response
- All are absolutely required for life

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## Functions

- Aldosterone helps in Na reabsorption & potassium excretion & preventing dehydration
- Cortisol stimulate protein breakdown, inhibition of tissue response in injury & antagonism to action of insulin
- Androgens helps in early development of male sex organ in childhood



## CORTISOL EFFECTS: Body Responses to Stress

- Permissive effect on glucagon
- Memory, learning & mood
- Gluconeogenesis
- Skeletal muscle breakdown
- Lipolysis, calcium balance
- Immune depression
- Circadian rhythms

## CORTISOL EFFECTS: Body Responses to Stress

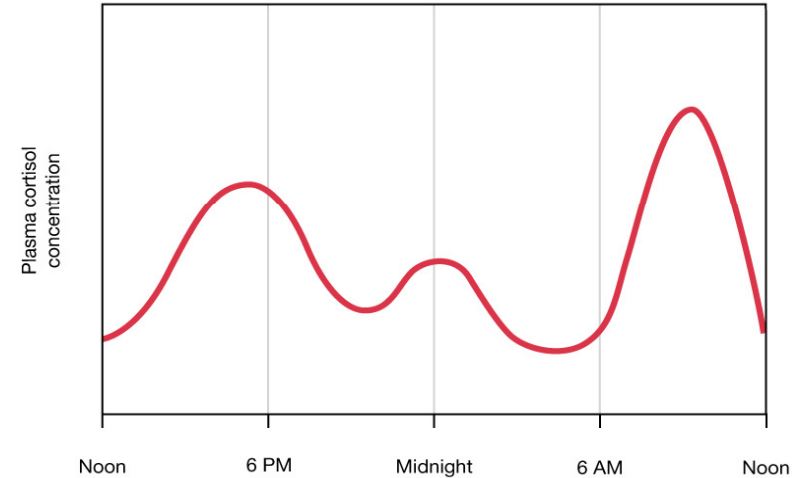


Figure 23-4: Circadian rhythm of cortisol secretion



## Control of Cortisol Secretion: Feedback Loops

- External stimuli
- Hypothalamic
- Anterior Pituitary
- Adrenal cortex
- Tissues

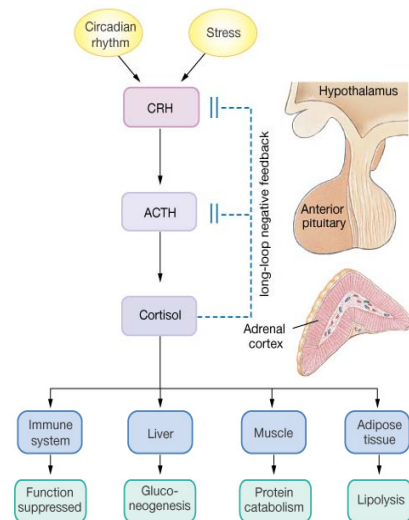


Figure 23-3: The control pathway for cortisol

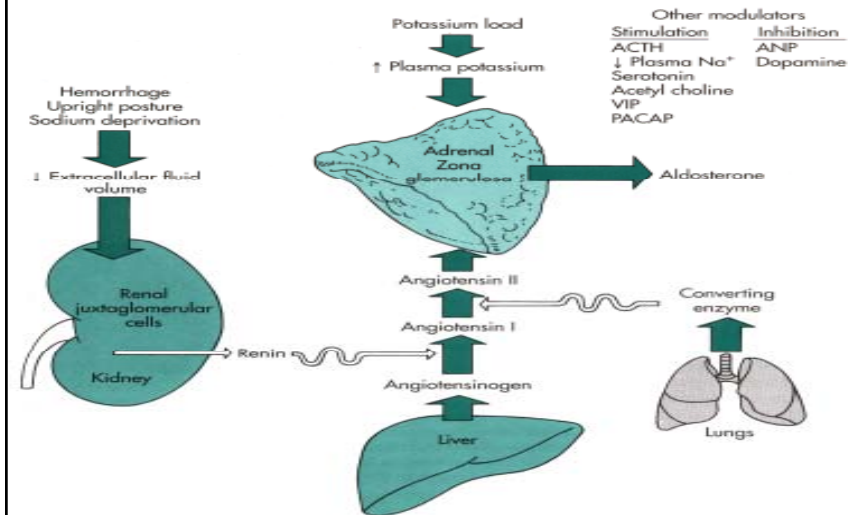
## Cortisol: Role in Diseases and Medication

- Use as immunosuppressant
  - Hyperimmune reactions (bee stings)
  - Serious side effects
- Hypercortisolism (Cushing's syndrome)
  - Tumors (pituitary or adrenal)
  - Iatrogenic (physician caused)
- Hypocortisolism (Addison's disease)

## Aldosterone

- Exclusively synthesized in Z. Glomerulosa
- Essential for life.
- Promotes sodium retention and Potassium elimination by the kidney.
- Expands ECF volume

## Regulation of Aldosterone Secretion



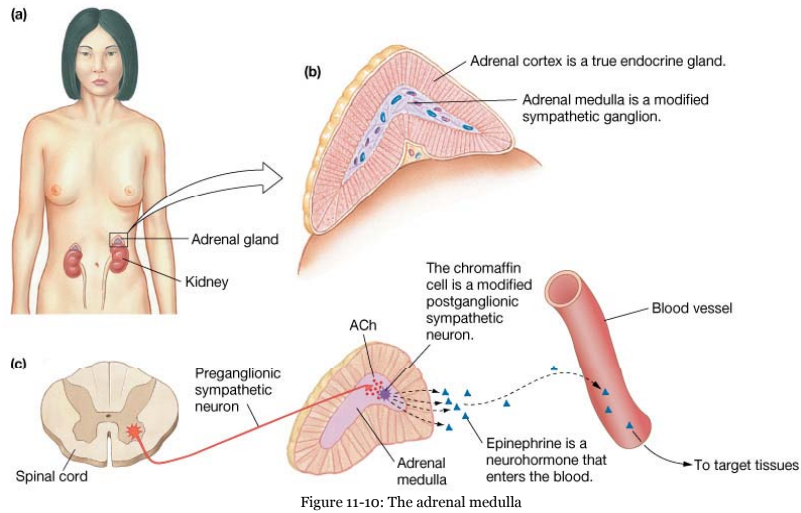
## Aldosterone: Role in diseases

- Complete failure to secrete aldosterone leads to death (dehydration, low blood volume).
- Hyperaldosterone states: Contribute to hypertension associated with increased blood volume.

## Adrenal Medulla: A Modified Sympathetic Ganglion

- Sympathetic stimulation
  - Catecholamine release to blood
    - Epinephrine
    - Norepinephrine
  - Travel to:
    - Multiple targets
    - Distant targets

# Adrenal Medulla: A Modified Sympathetic Ganglion



# Mechanism: Norepinephrine Release and Recycling

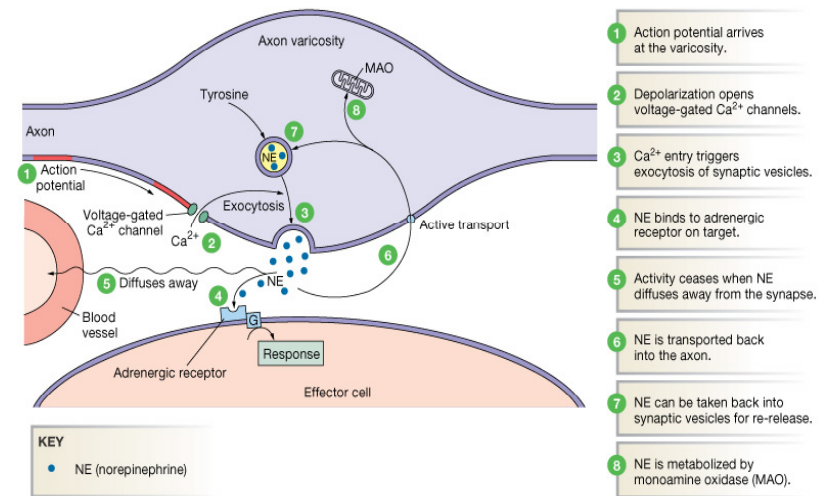


Figure 11-9: Norepinephrine release at a varicosity of a sympathetic neuron

## Review of Efferent Pathways: Motor & Autonomic

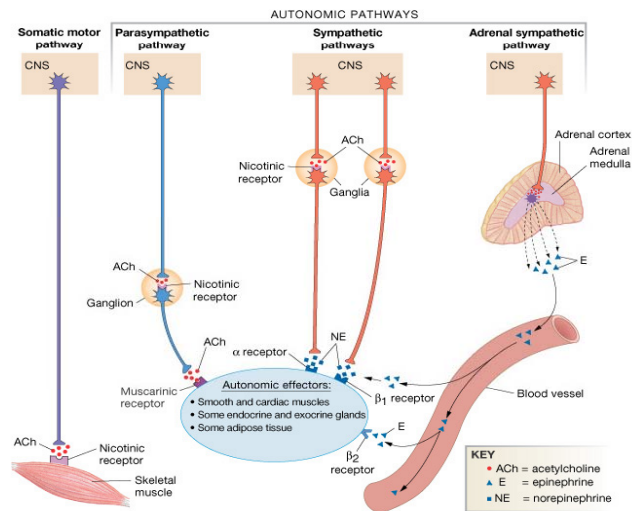


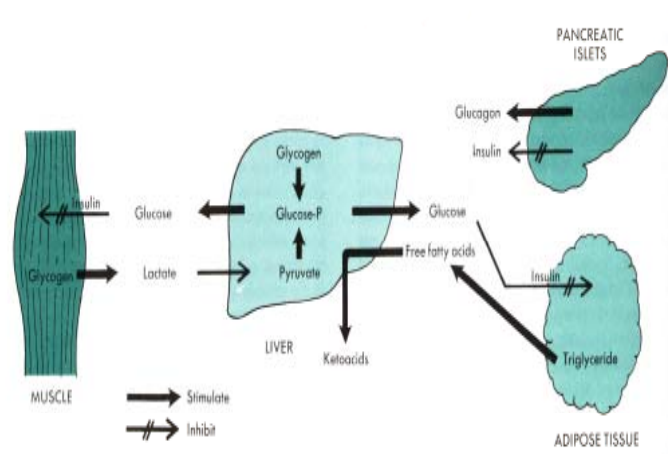
Figure 11-11: Summary of efferent pathways

## Catecholamines: Activity

- Stimulates the “fight or flight” reaction
- Increased plasma glucose levels
- Increased cardiovascular function
- Increased metabolic function
- Decreased gastrointestinal and genitourinary function



## Activity of Epinephrine



## Biologic Actions-Mineralocorticoids

### Aldosterone

**MOA:** transcription of enzymes and proteins

**Major actions:**  $\uparrow$  Na reabsorption in distal tubule

**Extrarenal effects:** Na reabsorption in saliva, sweat, stool

PathophysiologyHypersecretion of Aldosterone

*1° aldosteronism* – Conn's syndrome

*2° aldosteronism* – liver/kidney disease

**SXS:** hypertension

hypokalemia

metabolic alkalosis

Pathophysiology

## Primary Hyperaldosteronism

$\uparrow$  Aldosterone  $\rightarrow$   $\uparrow$  Na retention  $\rightarrow$   $\left[ \begin{array}{l} \uparrow \text{ECF volume} \\ + \\ \uparrow \text{Renal perfusion pressure} \end{array} \right] \rightarrow$   
 $\downarrow$  Renin

## Secondary Hyperaldosteronism

$\left[ \begin{array}{l} \uparrow \text{Na} \\ + \\ \uparrow \text{ECF} \end{array} \right] \rightarrow$   
 retention  $\downarrow$  Renal perfusion  $\rightarrow$   $\uparrow$  Renin  $\rightarrow$   $\uparrow$  Aldosterone  $\rightarrow$

Pathophysiology

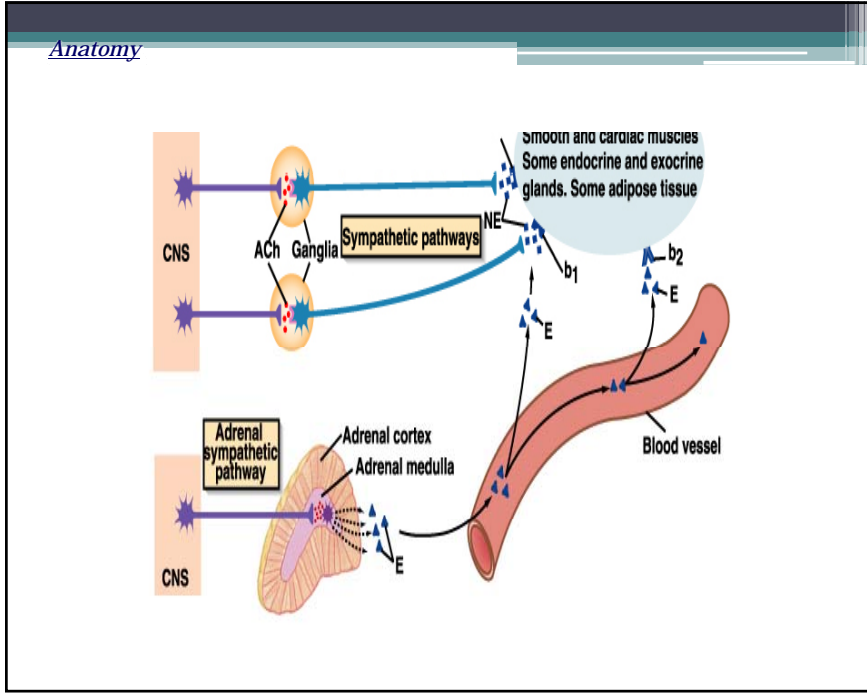
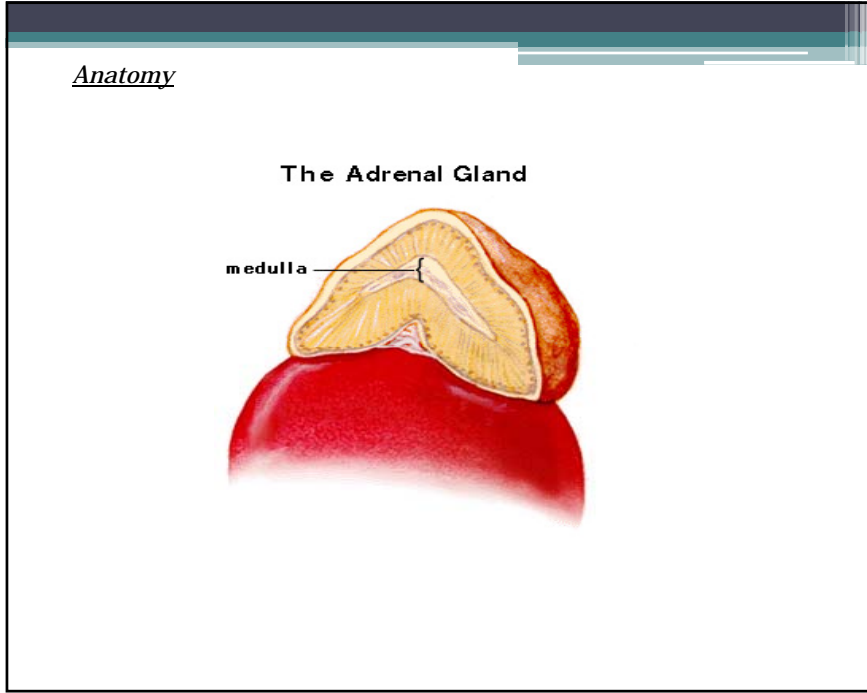
Hyposecretion of Aldosterone

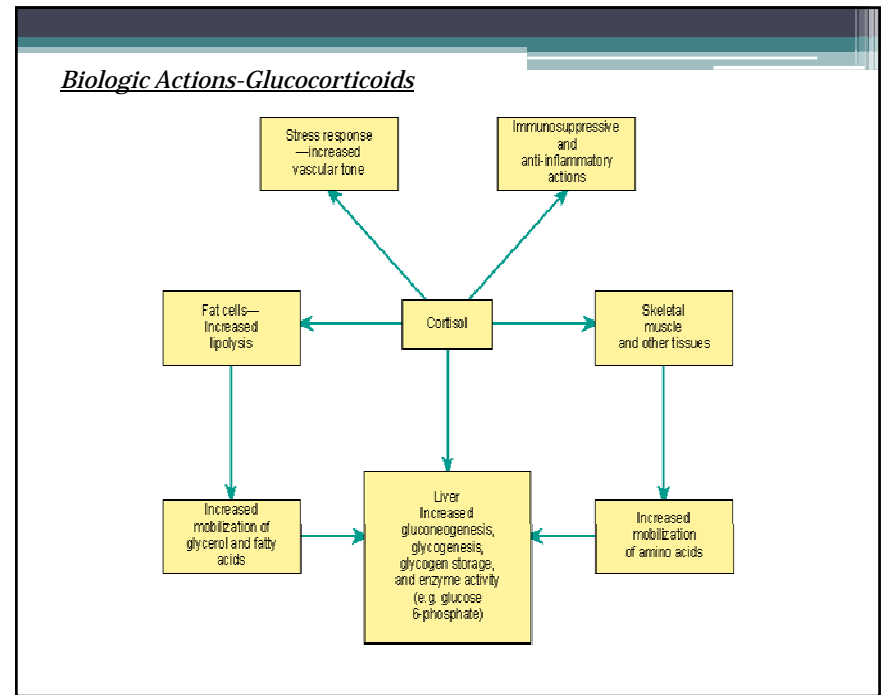
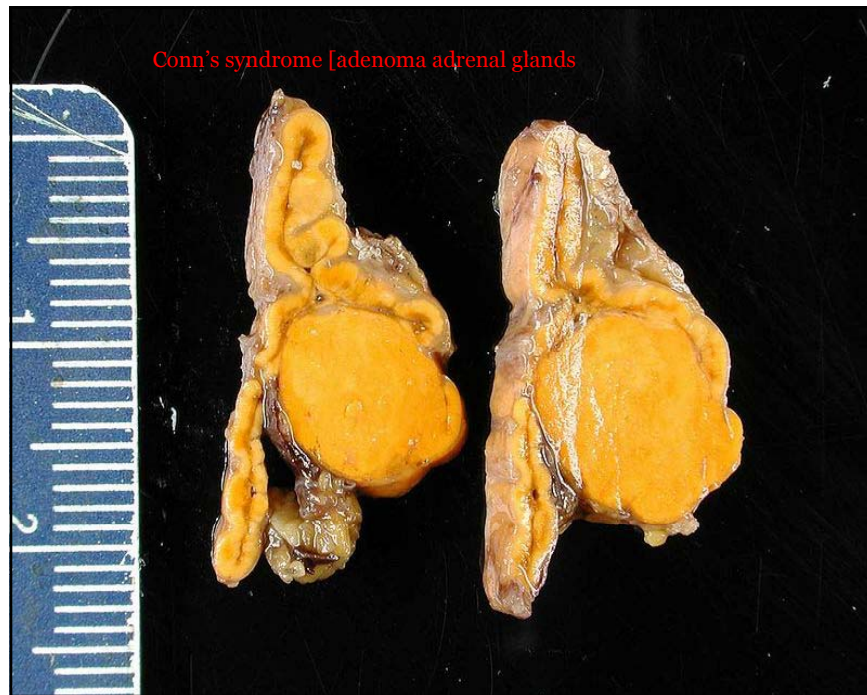
*1° hyposecretion* – Addisons' dse

*2° hyposecretion* – kidney damage

*SXS*: hypovolemia  
hyponatremia  
hyperkalemia

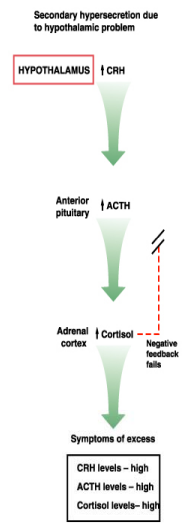




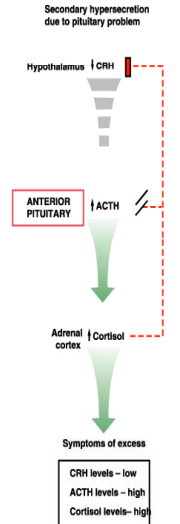


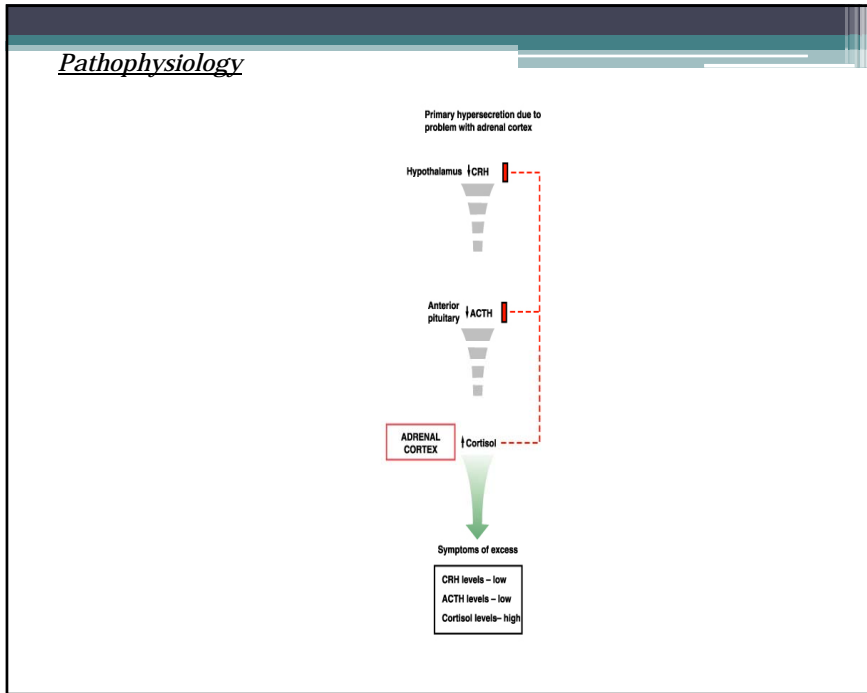


Pathophysiology



Pathophysiology





### Pathophysiology

#### Major Functions of Cortisol and Their Clinical Expression

Effect	Clinical expression	
	Cortisol Deficiency	Cortisol Excess
<b>Carbohydrate metabolism</b>		
Increased gluconeogenesis	Hypoglycemia	Hyperglycemia
Decreased glucose utilization		
Decreased sensitivity to insulin	Insulin sensitivity	Insulin resistance
<b>Protein metabolism</b>		
Decreased extrahepatic amino acid utilization	Hypoglycemia	Decreased protein structure of bone, skin, muscle
Increased gluconeogenesis		Poor wound healing
<b>Fat metabolism</b>		
Increased lipolysis, decreased lipogenesis	Weight loss	Hyperlipemia
Distribution of fat		Redistribution of body fat, truncal obesity
<b>Circulatory</b>		
Maintain ECF volume	Vasodilation	Hypertension
Maintain capillary integrity	hypotension	
<b>Mineral-corticoid</b>		
Sodium retention	Hypovolemia	Hypervolemia
Potassium excretion	Hyponatremia	Hypematremia
	Hyperkalemia	Hypokalemia
<b>Inflammatory and immune responses</b>		
Stabilize lysosomes	Propensity toward autoimmune disease	Decreased inflammatory response
Suppress synthesis of antibodies		Increased susceptibility to infection
Decrease capillary permeability		Decreased fibrous tissue formation
Decrease phagocytosis		
<b>Hematopoietic</b>		
Stimulate red cell production	Anemia	Erythrocytosis
Lympholysis	Lymphocytosis	Lymphopenia
Inhibit neutrophil accumulation at inflammatory sites		Leukocytosis
<b>Central nervous system</b>		
	Anorexia	Euphoria
	Fatigue	Depression
<b>Hypothalamic-pituitary feedback control of ACTH</b>	Increased ACTH secretion	Decreased ACTH secretion
	Pigmentation	If secondary to stimulation by hypothalamic-pituitary axis, ACTH increased

*Pathophysiology*



*Pathophysiology*

