Adrenal cortex and medulla hormones and their effects

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Adrenal (Suprarenal) Glands

- Adrenal glands are paired, pyramid-shaped organs at the top of the kidneys.

- Weigh 6-10 g.
- Structurally and functionally, they are two glands in one
- Each part behaves as a separate and independent endocrine gland
  - **Adrenal cortex** (80-90%)– glandular tissue derived from embryonic mesoderm
  - **Adrenal medulla** (10-20%)– formed from neural ectoderm, can be considered a modified sympathetic ganglion

Adrenal Cortex

- Synthesizes and releases steroid hormones (corticosteroids)
- No nerve supply
- Different corticosteroids are produced in each of the three layers:
  - Zona glomerulosa – mineralocorticoids (mainly aldosterone)
  - Zona fasciculata – glucocorticoids +Androgens (mainly cortisol and corticosterone)
  - Zona reticularis – gonadocorticoids + glucocorticoids (mainly dehydroepiandrosterone DHEA)

Steroid Hormones

- Steroids are derivatives of cholesterol
- Cholesterol is from the lipid droplets in cortical cells
- Removed cholesterol is replenished by cholesterol in LDL in blood or synthesized from acetate
- Steroid hormones are synthesized and secreted on demand (not stored)

Steroid Hormones

- The first and rate-limiting step in the synthesis of all steroid hormones is conversion of cholesterol to pregnenolone by the enzyme cholesterol dismolase (cholesterol side chain cleavage enzyme (SCC))

- Newly synthesized steroid hormones are rapidly secreted from the cell

- Following secretion, all steroids bind to some extent to plasma proteins: CBG (corticosteroid binding globulin) and albumin

Mineralocorticoids-Aldosterone

- A corticoid that regulates the mineral salts in the body
- Stimulated by circulating angiotensin
- Mainly acts on the sodium ion (Na+)
  - Stimulating the reabsorption of sodium ions in the kidney tubules
  - Decreasing the sodium ion content of sweat
  - Simultaneously, excretion of potassium by the kidneys is increased
- Regulation of the blood and fluid volumes in the body

Glucocorticoids - Cortisol

- Influence metabolism of most body cells
- Blood levels of glucocorticoids increase significantly during stress, which helps the body to negotiate the crisis
- Chronic excess of cortisol has significant anti-inflammatory and anti-immune effects and glucocorticoid drugs are often used to control symptoms of many chronic inflammatory disorders, such as rheumatoid arthritis or allergic responses
- The most important glucocorticoid is cortisol (small amounts of cortisone and corticosterone)
  - promote gluconeogenesis or formation of glucose from noncarbohydrate molecules, especially fats and proteins

Regulation of glucocorticoid secretion

- Hypothalamic-pituitary-adrenal (HPA) axis

Androgens (Gonadocorticoids)

- The amount of sex steroids produced by zona reticularis is insignificant compared to the amounts secreted by the gonads

- These hormones may contribute to the onset of puberty and the appearance of axillary and pubic hair in both males and females
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- In adult women adrenal androgens (male sex hormones, especially testosterone) may be, at least partially, responsible for the sex drive

Pathology of the adrenal cortex

- Hyperadrenalism
  - Referred as Cushing's disease and can be caused by a cortisol-secreting tumor in the adrenal glands, ACTH-secreting tumour of the pituitary, or ACTH secreted by abdominal carcinoma
  - Most often results from the clinical administration of pharmacological (very high) doses of glucocorticoid drugs.
  - The symptoms include a persistent hyperglycaemia, dramatic loss of muscle and bone proteins, and water and salt retention, leading to hypertension and edema - one of its signs is a swollen "moon" face. The only treatment is a surgical removal of tumour or discontinuation of the drug.

Pathology of the adrenal cortex

- Hypoadrenalism
  - Referred as Addison's disease and involves significant reduction in plasma glucose and sodium, very high levels of potassium and loss of weight
  - Usual treatment is corticosteroid replacement therapy

Adrenal Medulla

- Made up of chromaffin cells which secrete the catecholamines

- Release hormones which are amines of catechol (dihydroxybenzene) → catecholamines
  - noradrenaline (norepinephrine) : chemical transmitter of the sympathetic nervous system
  - adrenaline (epinephrine)

- Innervated by preganglionic sympathetic fibers and its activity augments that of the sympathetic nervous system throughout the body

Adrenal Medulla

- Active under a wide variety of stress conditions
  - Anger
  - Fear
  - Cold
  - Low blood sugar
  - Low blood pressure
  - Cerebral anoxia and asphyxia

Adrenal Medulla

- Epinephrine and Norepinephrine have very similar effects on their target organs.
    - Epinephrine is the more potent stimulator of the heart rate and strength of contraction, and metabolic activities, such as breakdown of glycogen and release of glucose).
    - Norepinephrine has great effect on peripheral vasoconstriction and blood pressure.