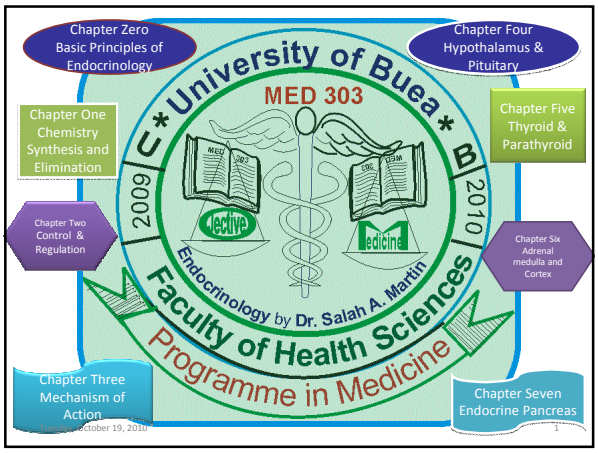
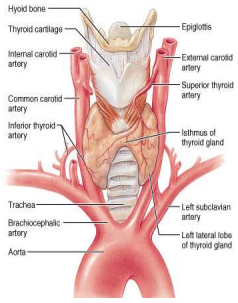


Thyroid Gland

- The largest endocrine gland, located in the anterior neck, consists of two lateral lobes connected by a median tissue mass called the *isthmus*
- Composed of follicles that produce the glycoprotein *thyroglobulin*
- Colloid (thyroglobulin + iodine) fills the lumen of the follicles and is the precursor of thyroid hormone



Thyroid Hormone (TH)

- Thyroid hormone – the body's major metabolic hormone
- Consists of two closely related iodine-containing compounds
  - T_4 – thyroxine; has two tyrosine molecules plus four bound iodine atoms
  - T_3 – triiodothyronine; has two tyrosines with three bound iodine atoms

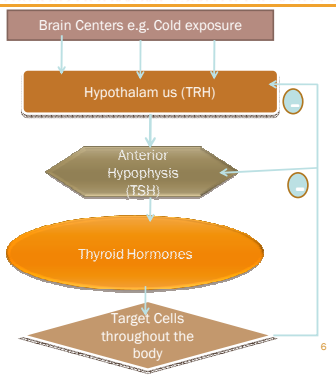
Effects of Thyroid Hormone

- TH is concerned with:
  - Glucose oxidation
  - Increasing metabolic rate
  - Heat production
- TH plays a role in:
  - Maintaining blood pressure
  - Regulating tissue growth
  - Developing skeletal and nervous systems
  - Maturation and reproductive capabilities

REGULATION OF THYROID HORMONE

- T_4 and T_3 bind to thyroxine-binding globulins (TBGs) produced by the liver
- Both bind to target receptors, but T_3 is ten times more active than T_4
- Peripheral tissues convert T_4 to T_3
- Mechanisms of activity are similar to steroids
- Regulation is by negative feedback
- Hypothalamic thyrotropin-releasing

CONTROL OF THYROID HORMONE SYNTHESIS AND SECRETION



Synthesis of Thyroid Hormone

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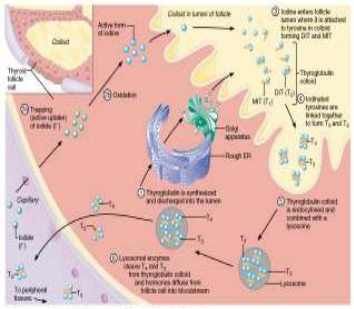
- Thyroglobulin is synthesized and discharged into the lumen
- Iodides (I^-) are actively taken into the cell, oxidized to iodine (I_2), and released into the lumen
- Iodine attaches to tyrosine, mediated by peroxidase enzymes, forming T_1 (monoiodotyrosine, or MIT), and T_2 (diiodotyrosine, or DIT)
- Iodinated tyrosines link together to form T_3 and T_4
- Colloid is then endocytosed and



Calcitonin

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- A peptide hormone produced by the parafollicular, or C, cells
- Lowers blood calcium levels in children
- Antagonist to parathyroid hormone (PTH)
- Calcitonin targets the skeleton, where it:
  - Inhibits osteoclast activity and thus bone resorption and release of calcium from the bone matrix
  - Stimulates calcium uptake and incorporation into the bone matrix
- Regulated by a humoral (calcium ion

Parathyroid Glands

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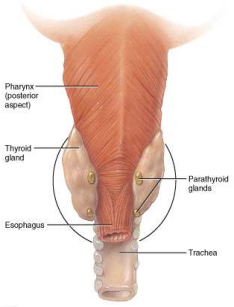
- Tiny glands embedded in the posterior aspect of the thyroid
- Cells are arranged in cords containing oxyphil and chief cells
- Chief (principal) cells secrete PTH
- PTH (parathormone) regulates calcium



Effects of Parathyroid Hormone

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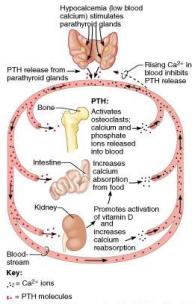
- PTH release increases Ca^{2+} in the blood as it:
  - Stimulates osteoclasts to digest bone matrix
  - Enhances the reabsorption of Ca^{2+} and the secretion of phosphate by the kidneys
  - Increases absorption of Ca^{2+} by intestinal mucosal cells
- Rising Ca^{2+} in the



ADRENAL (SUPRARENAL) GLANDS

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- Adrenal glands – paired, pyramid-shaped organs atop the kidneys
- Structurally and functionally, they are two glands in one
  - Adrenal medulla – nervous tissue that acts as part of the SNS
  - Adrenal cortex – glandular tissue derived from embryonic mesoderm

Adrenal Cortex

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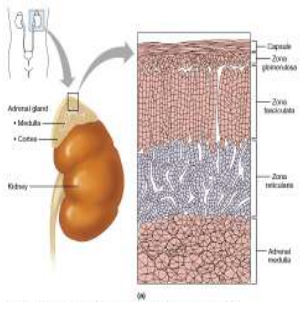
- Synthesizes and releases steroid hormones called *corticosteroids*
- Different corticosteriods are produced in each of the three layers
  - Zona glomerulosa – mineralocorticoids (chiefly aldosterone)
  - Zona fasciculata – glucocorticoids (chiefly cortisol)
  - Zona reticularis –

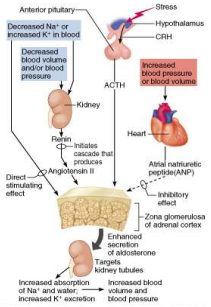


Mineralocorticoids

- Regulate the electrolyte concentrations of extracellular fluids
- Aldosterone – most important mineralocorticoid
  - Maintains Na^+ balance by reducing excretion of sodium from the body
  - Stimulates reabsorption of Na^+ by the kidneys
- Aldosterone secretion is stimulated by:
  - Rising blood levels of K^+
  - Low blood Na^+

The Four Mechanisms of Aldosterone Secretion

- Renin-angiotensin mechanism – kidneys release renin, which is converted into angiotensin II that in turn stimulates aldosterone release
- Plasma concentration of sodium and potassium – directly influences the zona glomerulosa cells
- ACTH – causes small increases of aldosterone during stress



Glucocorticoids (Cortisol)

- Help the body resist stress by:
  - Keeping blood sugar levels relatively constant
  - Maintaining blood volume and preventing water shift into tissue
- Cortisol provokes:
  - Gluconeogenesis (formation of glucose from noncarbohydrates)
  - Rises in blood glucose, fatty acids, and amino acids

EXCESSIVE LEVELS OF GLUCOCORTICOIDS

- Excessive levels of glucocorticoids:
  - Depress cartilage and bone formation
  - Inhibit inflammation
  - Depress the immune system
  - Promote changes in cardiovascular, neural, and gastrointestinal function

Gonadocorticoids (Sex Hormones)

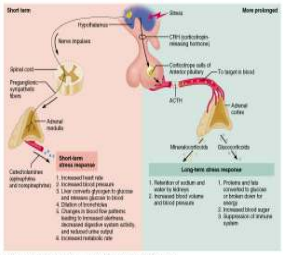
- Most gonadocorticoids secreted are androgens (male sex hormones), and the most important one is testosterone
- Androgens contribute to:
  - The onset of puberty
  - The appearance of secondary sex characteristics
  - Sex drive in females
- Androgens can be converted into estrogens after menopause

Adrenal Medulla

Activity

- Made up of chromaffin cells that secrete epinephrine and norepinephrine
- Secretion of these hormones causes:
  - Blood glucose levels to rise
  - Blood vessels to constrict
  - The heart to beat faster
  - Blood to be diverted to the brain, heart, and skeletal muscle
- Epinephrine is the more potent stimulator of the heart and metabolic activities
- Norepinephrine is more influential on peripheral vasoconstriction

Stress and the Adrenal Gland



Pancreas

- A triangular gland, which has both exocrine and endocrine cells, located behind the stomach
- Acinar cells produce an enzyme-rich juice used for digestion (exocrine product)
- Pancreatic islets (islets of Langerhans) produce hormones (endocrine products)
- The islets contain two major cell types:
  - Alpha (α) cells that produce glucagon
  - Beta (β) cells that produce insulin

Hormones of the pancreas

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Glucagon

- A 29-amino-acid polypeptide hormone that is a potent hyperglycemic agent
- Its major target is the liver, where it promotes:
  - Glycogenolysis – the breakdown of glycogen to glucose
  - Gluconeogenesis – synthesis of glucose from lactic acid and noncarbohydrates
  - Release of glucose to the blood from liver cells

Insulin

- A 51-amino-acid protein consisting of two amino acid chains linked by disulfide bonds
- Synthesized as part of proinsulin and then excised by enzymes, releasing functional insulin
- Insulin:
  - Lowers blood glucose levels
  - Enhances transport of glucose into body cells
  - Counters metabolic activity that would enhance blood glucose levels

Effects of Insulin Binding

- The insulin receptor is a tyrosine kinase enzyme
- After glucose enters a cell, insulin binding triggers enzymatic activity that:
  - Catalyzes the oxidation of glucose for ATP production
  - Polymerizes glucose to form glycogen
  - Converts glucose to fat (particularly in adipose tissue)

Levels

The hyperglycemic effects of glucagon and the hypoglycemic effects of insulin

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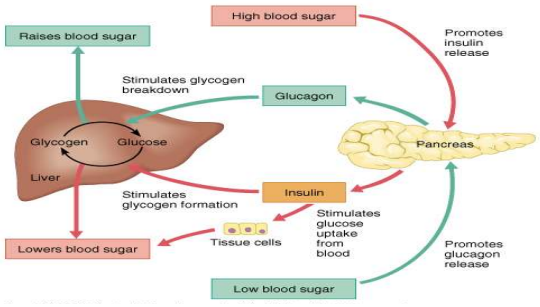

Diabetes Mellitus (DM)

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- Results from hyposecretion or hypoactivity of insulin
- The three cardinal signs of DM are:
  - Polyuria – huge urine output
  - Polydipsia – excessive thirst
  - Polyphagia – excessive hunger and food consumption