ENDOCRINE SYSTEM

The endocrine system consists of **glands and organs that make hormones and release them directly into the blood**, so that hormones can travel to tissues and organs throughout the body. Endocrine glands are **ductless**, widely separated, and have **no physical connections** with each other.

Glands are groups of secretory cells surrounded by an extensive network of capillaries that facilitate the diffusion of hormones from secretory cells into the bloodstream.

Hormones are carried in the bloodstream to target tissues and organs that may be distant. They influence **cell growth and metabolism**.

A **hormone** is a chemical molecule that is released in one part of the body but regulates the activities of cells in other parts of the body.

Together with the **autonomic nervous system (ANS)**, the endocrine system maintains **homeostasis**.

- ANS brings about **rapid changes**
- Endocrine system brings about **slower and more precise adjustments**

ENDOCRINE GLANDS

Main endocrine glands

- Pituitary gland
- Thyroid gland
- Parathyroid gland
- Pancreas
- Adrenal gland
- Gonads – ovaries and testes

Other hormone-secreting organs

- Leptin by adipose tissue
- Atrial natriuretic peptide (ANP) by heart
- Stomach
- Liver
- Small intestine
- Placenta

CLASSIFICATION OF HORMONES

Based on mode of action

1. Circulating hormones
2. Local hormones

Circulating hormones

- Most hormones are circulating hormones
- Pass from secretory cells into interstitial fluid and then into blood

Local hormones

- Act locally on neighboring cells or on the same cell that secreted them
- Do not enter the bloodstream

Paracrines – local hormones that act on neighboring cells
Autocrines – local hormones that act on the same cell that secreted them

Example:

- Interleukin-2 (IL-2) secreted by helper T-cells – acts as both autocrine and paracrine

CHEMICAL CLASSIFICATION OF HORMONES

Lipid-soluble hormones

- Steroid hormones (glucocorticoids, mineralocorticoids) – derived from cholesterol
- Thyroid hormones (T3, T4) – synthesized by attaching iodine to amino acid tyrosine
- Nitric oxide (NO) – gas, acts as both hormone and neurotransmitter

Water-soluble hormones

Amine hormones

Synthesized by decarboxylation and modification of certain amino acids
Examples:

- Epinephrine
- Norepinephrine
- Dopamine
- Histamine
- Serotonin
- Melatonin

Peptide and protein hormones

- Peptide hormones – Antidiuretic hormone, Oxytocin
- Protein hormones – Growth hormone, Insulin

Glycoprotein hormones

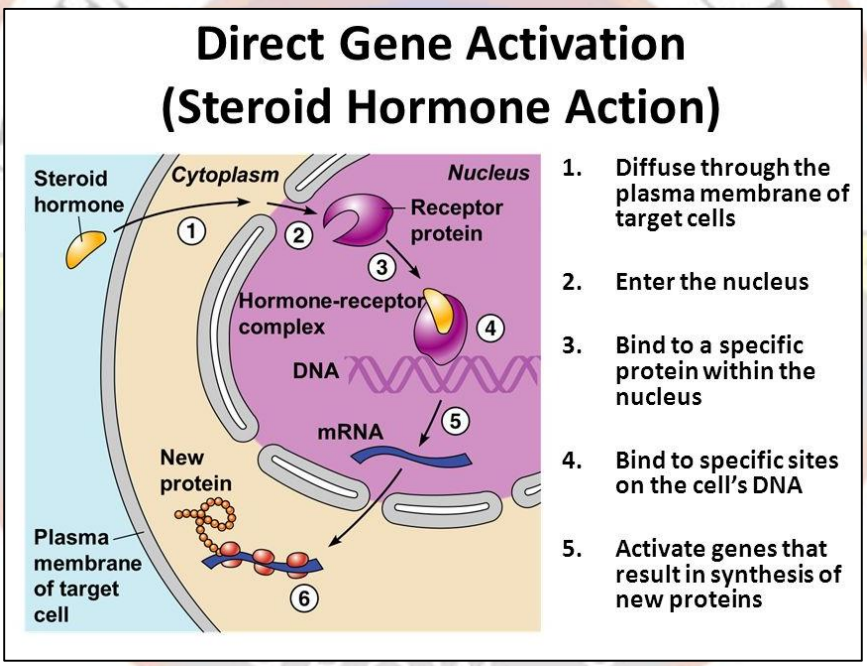
- TSH
- Glucagon
- PTH

Eicosanoid hormones

Derived from arachidonic acid (20-carbon fatty acid)
Examples:

- Prostaglandins (PGs)
- Leukotrienes (LTs)

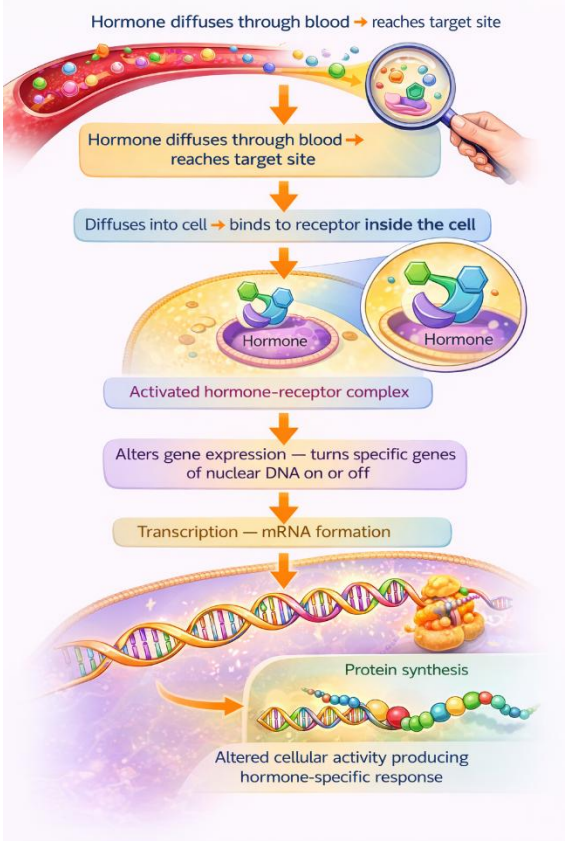
MECHANISM OF HORMONE ACTION

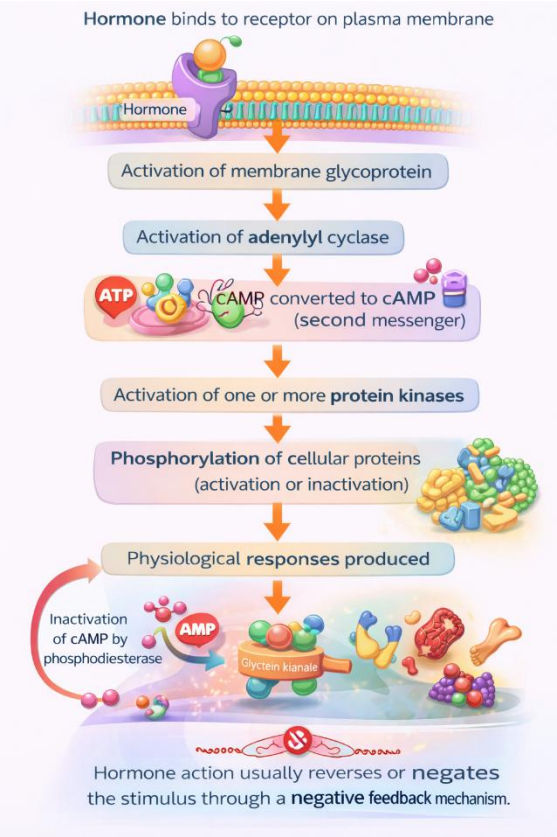


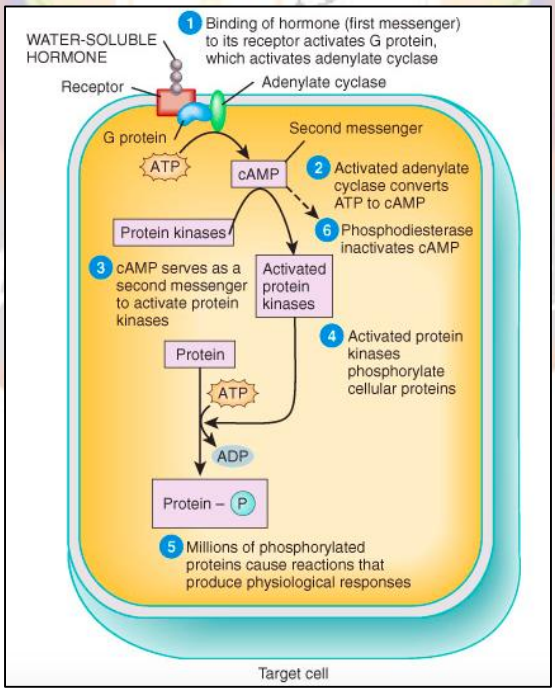
A hormone binds to a **specific receptor** on the target cell and acts as a switch to influence chemical or metabolic reactions inside the cell.

- Receptors for peptide hormones – located on the **cell membrane**
- Receptors for lipid-soluble hormones – located **inside the cell**

ACTION OF LIPID-SOLUBLE HORMONES **ACTION OF WATER-SOLUBLE HORMONES**







PITUITARY GLAND AND HYPOTHALAMUS

The pituitary gland (hypophysis) is the **master endocrine gland** because it secretes several hormones that control other endocrine glands.

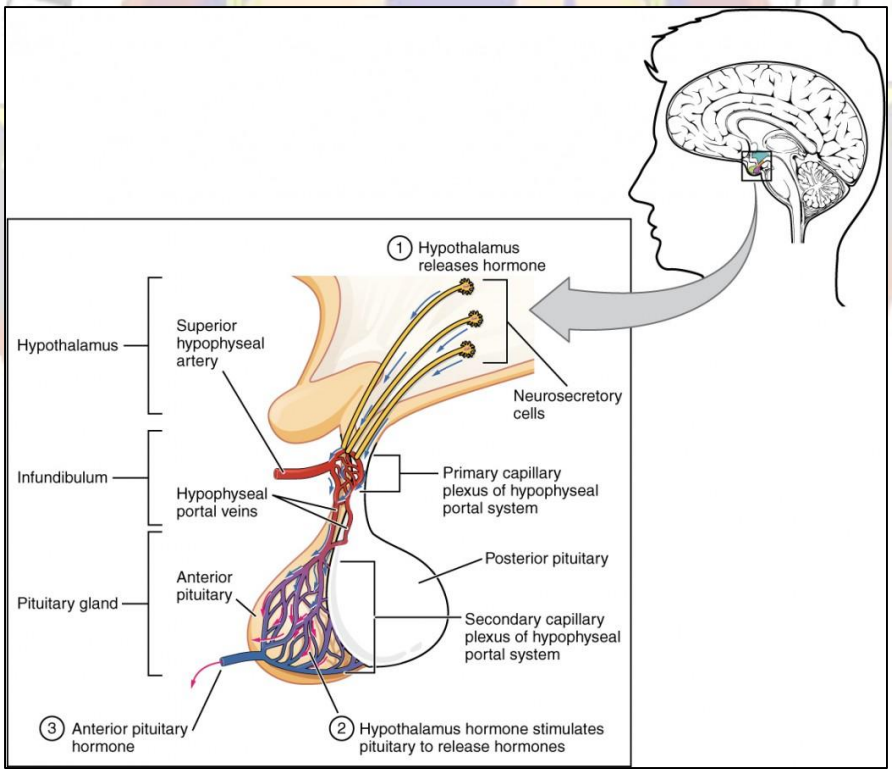
The pituitary gland itself is controlled by the **hypothalamus**.
Both act together as a **functional unit**.

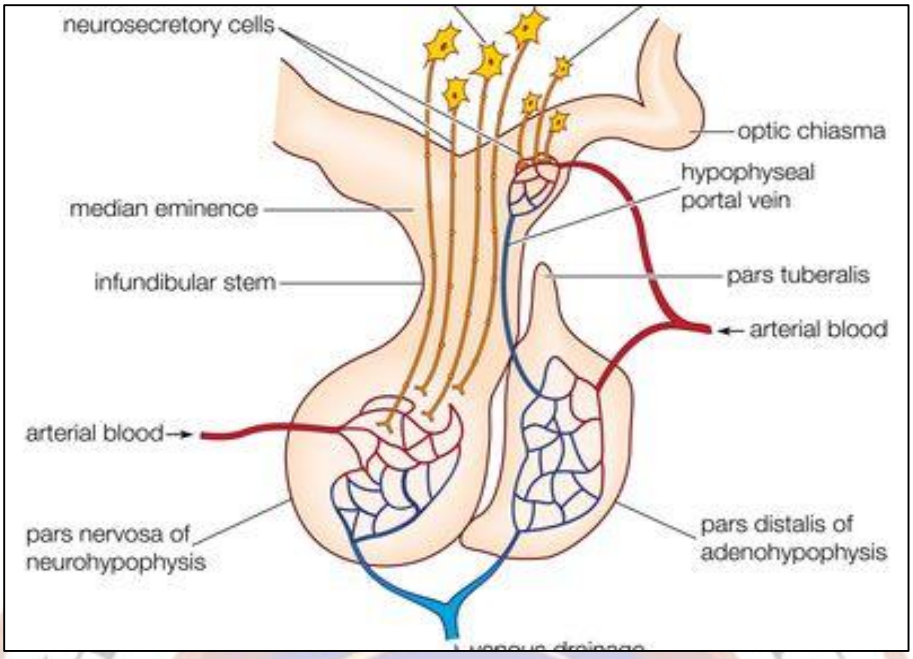
The pituitary gland is a **pea-shaped gland** lying in the **hypophyseal fossa of the sphenoid bone**.

It is attached to the hypothalamus by a stalk called the **infundibulum**.

The pituitary gland has **two separate portions**:

1. Anterior pituitary
2. Posterior pituitary





ANTERIOR PITUITARY

Also called **adenohypophysis**.
Composed of glandular epithelium.

It consists of two parts:

- Pars distalis
- Pars tuberalis

Hormones of anterior pituitary

- Growth hormone (GH)
- Thyroid stimulating hormone (TSH)
- Prolactin
- Adrenocorticotropic hormone (ACTH)
- Luteinizing hormone (LH)
- Follicle stimulating hormone (FSH)
- Melanocyte stimulating hormone (MSH)

POSTERIOR PITUITARY

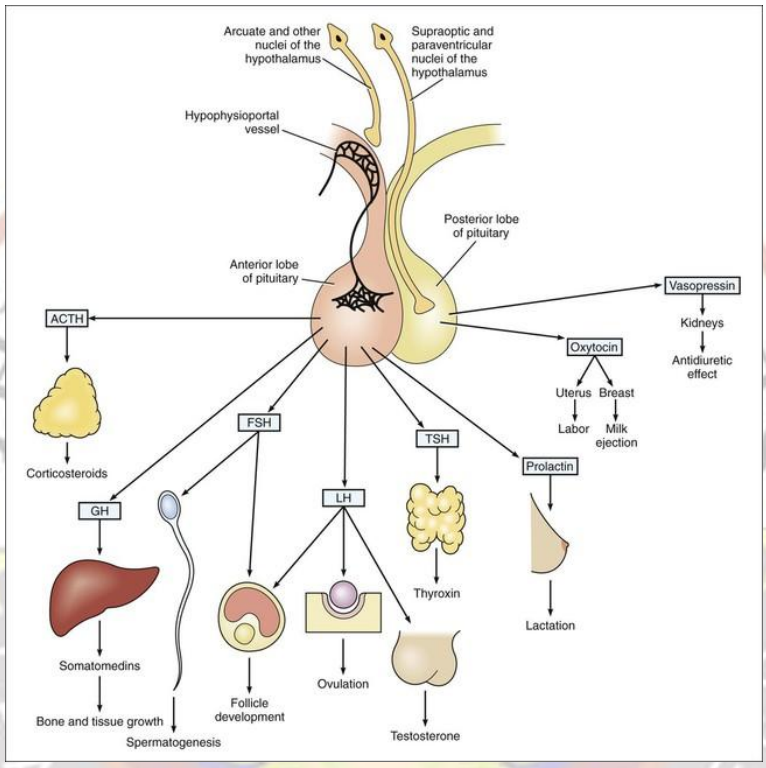
Also called **neurohypophysis**.
Composed of nervous tissue and is a downgrowth from the brain.

It consists of two parts:

- Pars nervosa
- Pars intermedia

Hormones of posterior pituitary

- Oxytocin
- Antidiuretic hormone (ADH)



BLOOD SUPPLY OF PITUITARY

Arterial supply

- Anterior lobe is supplied indirectly by blood that has already passed through a capillary bed in the hypothalamus
- Posterior lobe is supplied directly

Venous drainage

- Venous blood containing hormones from both lobes leaves the gland through short veins into venous sinuses between layers of dura mater

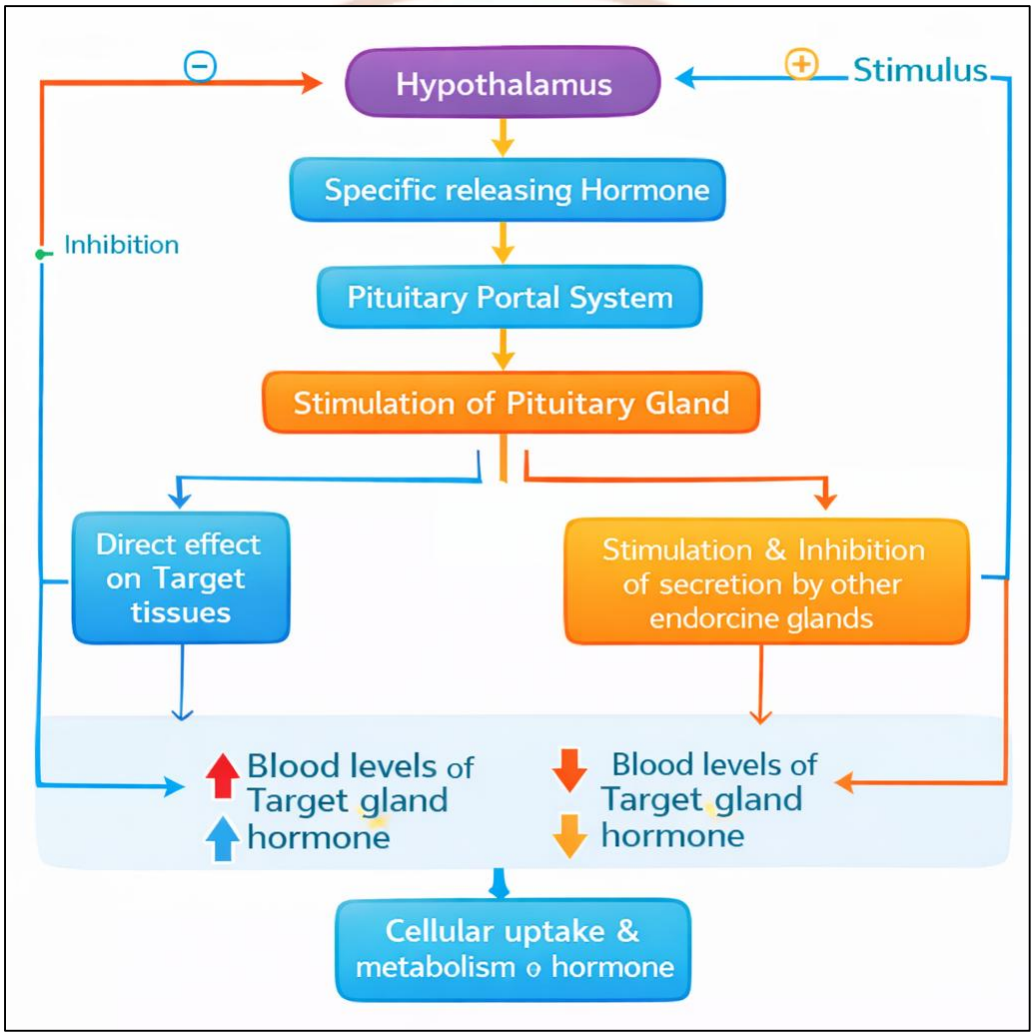
HYPOTHALAMIC CONTROL OF PITUITARY

The hypothalamus controls hormone release from both lobes of pituitary.

It produces:

- 5 releasing hormones
- 2 inhibiting hormones

Estrogen and progesterone prepare the uterus for implantation of a fertilized ovum and prepare mammary glands for milk secretion.



POSTERIOR PITUITARY

Posterior pituitary does **not synthesize hormones**.
It stores and releases hormones synthesized in the hypothalamus.

Neurosecretory cell bodies are located in:

- Supraoptic nucleus
- Paraventricular nucleus

Axons form the **hypothalamo-hypophyseal tract**.

Hormones are synthesized in neuron cell bodies, transported along axons, stored in vesicles, and released into blood by **exocytosis**.

OXYTOCIN

Target tissues

- Uterine smooth muscle
- Muscle cells of lactating breast

Neurosecretory cells secrete oxytocin in response to:

- Uterine distension
- Stimulation of nipples

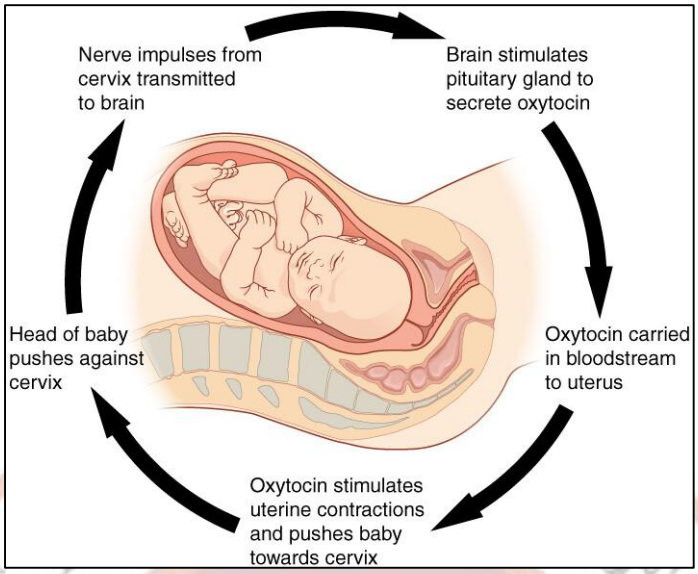
Functions

- Stimulates uterine contractions during childbirth
- Stimulates contraction of myoepithelial cells of mammary glands – milk ejection

Oxytocin levels also increase during sexual arousal in both males and females, increasing smooth muscle contraction, glandular secretion, and ejaculation in males.

In females, contraction of vaginal and uterine smooth muscle promotes movement of sperm towards uterine tubes.

Oxytocin is also involved in **social recognition and bonding** between mother and newborn.



ANTIDIURETIC HORMONE (ADH / VASOPRESSIN)

ADH reduces urine output.

Targets

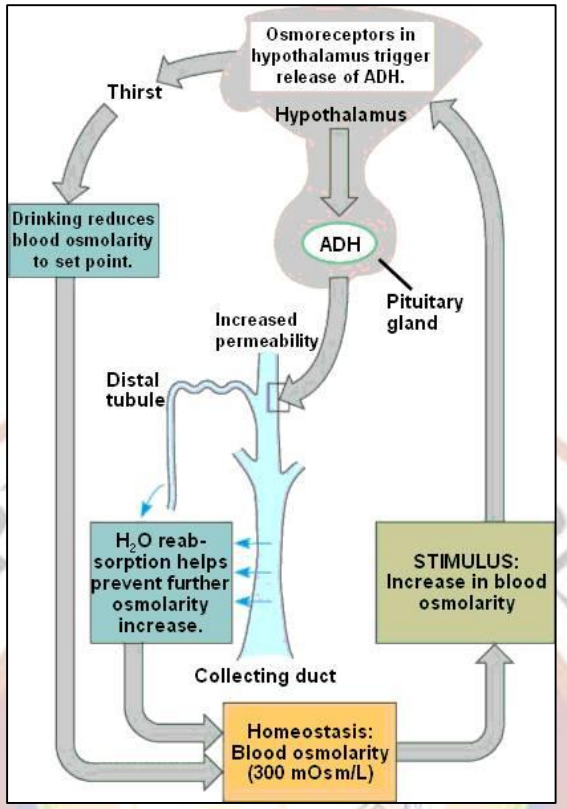
- Kidneys
- Sweat glands
- Arterioles

ADH is secreted in response to:

- Increased blood osmotic pressure
- Dehydration
- Loss of blood volume
- Pain or stress

Functions

- Conserves body water by decreasing urine volume
- Decreases water loss through perspiration
- Increases blood pressure by vasoconstriction



DISORDERS OF PITUITARY GLAND

Hypersecretion of anterior pituitary hormones

Most common cause is prolonged hypersecretion of GH by tumors.

Tumors enlarge and cause:

- Compression of nearby structures
- Hyposecretion of other pituitary hormones
- Damage to optic nerves
- Visual disturbances

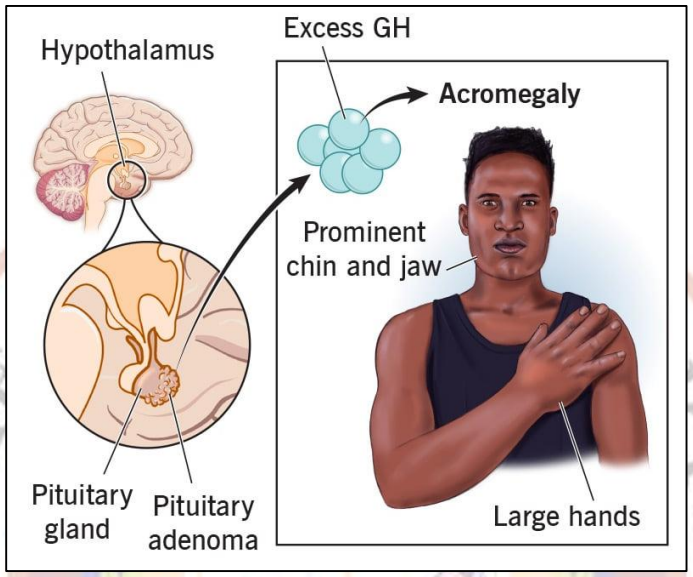
Effects of increased GH

- Excessive growth of bones
- Enlargement of internal organs
- Excess connective tissue formation
- Enlargement of heart and increased BP
- Decreased glucose tolerance and predisposition to diabetes mellitus

Gigantism

- Increased GH in children
- Epiphyseal cartilage still growing
- Height may reach 2.1–2.4 m

Acromegaly



- Occurs in adults after epiphyseal closure
- Thickened bones and soft tissues
- Coarse facial features
- Enlarged jaw, tongue, hands and feet

Hyperprolactinaemia

- Caused by prolactin-secreting tumor
- Galactorrhoea
- Amenorrhoea
- Sterility in women
- Impotence in men

Hyposecretion of anterior pituitary hormones

Causes include:

- Tumors
- Trauma
- Infection
- Ischaemic necrosis

- Ionising radiation
- Cytotoxic drugs

Sheehan's syndrome

- Postpartum pituitary necrosis due to severe hemorrhage
- Failure of lactation
- Hypofunction of target glands

Pituitary dwarfism (Lorain-Levi syndrome)

- GH deficiency in childhood
- Short stature with normal proportions
- Normal intelligence
- Delayed puberty

Frohlich's syndrome

- Panhypopituitarism
- Obesity, lack of sexual development
- Learning disabilities

Hormones (Anterior Pituitary)	Hypothalamic releasing hormone (stimulates secretion)	Hypothalamic inhibiting hormone (suppresses secretion)	Functions
Growth Hormone (or) Somatotropin	GHRH	GHRIH or GHIH or Somatostatin	1. Stimulates growth & division of most body cells 2. Stimulates & promotes growth of organs 3. Promotes metabolism
Thyroid Stimulating Hormone (TSH)	Thyrotrophin Releasing Hormone (TRH)	GHIH	Stimulates synthesis & secretion of thyroid hormones (T3, T4) by thyroid gland
ACTH or Corticotrophin	Corticotrophin Releasing Hormone (CRH)	-	Stimulates growth & activity of adrenal cortex - ↑ output of glucocorticoids esp, cortisol
Follicle Stimulating Hormone (FSH)	Gonadotrophin Releasing Hormone (GnRH)	-	Males - Stimulates production of spermatozoa by the testes Females -Stimulates production of ova – initiate the development of ovarian follicles

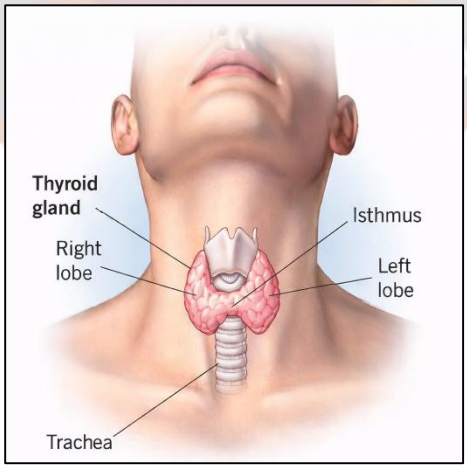
Leutinizing Hormone (LH) or Interstitial cell stimulating Hormone (ICSH in males)	GnRH	-	Males - Stimulates testes to produce testosterone Females - Stimulate secretion of estrogen (with FSH), progesterone - Stimulates ovulation - Formation of corpus luteum
Prolactin (Lactogenic Hormone)	Prolactin releasing Hormone (PRH)	Prolactin Inhibiting Hormone i.e Dopamine	Together with other hormones promotes milk production by mammary glands
Melanocyte Stimulating Hormone (MSH)	Corticotrophin releasing Hormone (CRH)	Dopamine	Exact role in humans unknown but may influence brain activity – In excess, can cause darkening of skin

DISORDERS OF POSTERIOR PITUITARY

Diabetes insipidus

- Rare condition
- Hyposecretion of ADH
- Excessive dilute urine (>10 L/day)
- Dehydration and intense thirst

THYROID GLAND



Butterfly-shaped gland located inferior to larynx and anterior to trachea.

Consists of:

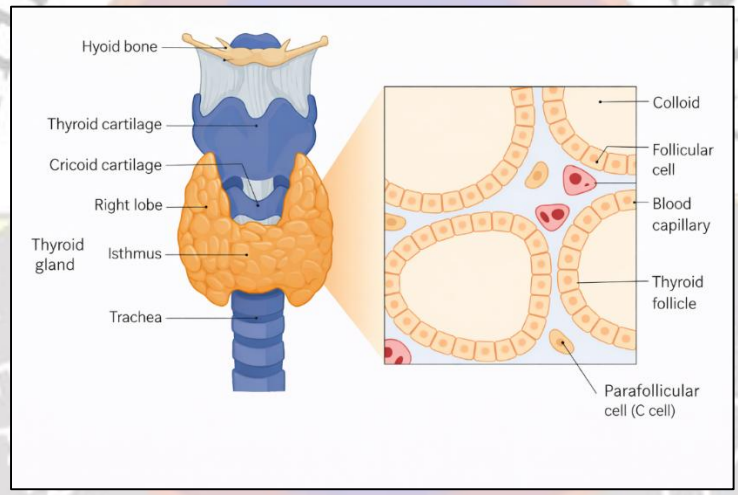
- Two lobes
- Isthmus

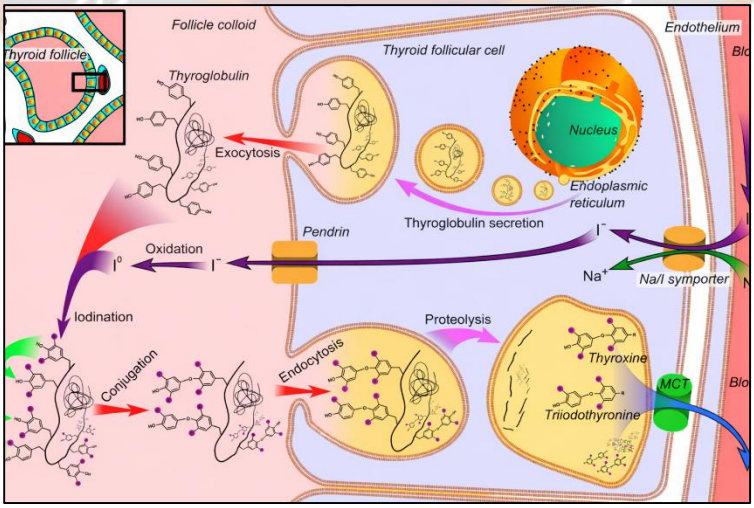
Weighs about **25 g**.

Made of thyroid follicles filled with colloid.
Follicular cells produce T3 and T4.
Parafollicular (C-cells) secrete **calcitonin**.

Blood & Nerve supply

- Arterial blood supply – superior & inferior thyroid arteries
- Venous return is by thyroid veins – then to internal jugular veins
- Recurrent laryngeal nerve





Formation, storage & release of thyroid hormones

- Iodine – essential for formation of thyroid hormones
- Main diet sources

- *Sea food*
- *Vegetables grown in iodine rich soil*
- *Iodinated table salt*

- Synthesis & secretion of T3 & T4 occurs as follows :

Iodine trapping

- Thyroid gland selectively takes up iodine from blood in the form of iodide (I-) – Iodine trapping

Synthesis of thyroglobulin

- Follicular cells also synthesise thyroglobulin in RER – exocytosis to lumen of follicle

Oxidation of Iodide

- I- cannot bind to tyrosine amino acids in thyroglogulin, until it undergoes oxidation to Iodine (I- - Io)
- Being oxidized, Io pass through membrane into lumen of follicle

Iodination of tyrosine

- Io react with tyrosine
- 1Io – monoiodotyrosine T1
- 2nd iodination – diiodotyrosine T2

Coupling of T1 &T2

- Two T2 join to form T4
- 1 T1 & 1 T2 join to form T3

Pinocytosis and digestion of colloid

- Colloid reenter follicular cells by pinocytosis, merge with lysosome
- Digestive enzymes break down TGB – leave off T3 & T4

Secretion of thyroid hormones

- T3 & T4 are lipid soluble – diffuse through plasma membrane into blood
- T4 secretion > T3, but T3 several times more potent

- In body cells, T4 converted to T3

Transport in blood

More than 99% of T3 & T4 combine with transport protein called thyroxine binding globulin

Actions of thyroid hormones

- Regulates gene expression – increase or decrease protein synthesis
- Enhance effects of other hormones ***ex:*** Epinephrine, Norepinephrine
- Functions of thyroid hormones:

Increase metabolic rate and heat production

- Metabolism of carbohydrates, lipids and proteins ↑ when BMR ↑
- ↑ BMR – more heat given off, body temperature ↑ – calorigenic effect

Enhance actions of catecholamines

- ↑ HR, more forceful heart beats, ↑ BP

Regulate development & growth of nervous tissue & bones

- Deficiency during fetal development, infancy or childhood causes severe mental retardation & stunted bone growth

Control of thyroid hormone secretion

- Begins in 3rd month of fetal life, increase at puberty & in women during reproductive years *esp*, during pregnancy

Calcitonin

- Secreted by parafollicular/ C-cells of thyroid gland
- ***Lowers blood calcium levels by***

1. Inhibiting the activity of osteoclasts (inhibit bone resorption)
2. On bone cells, promote their storage of calcium
3. Kidney tubules, inhibit reabsorption of calcium

- Opposite of PTH
- Increase blood calcium levels – stimulate release of calcitonin

Hyperthyroidism/ Thyrotoxicosis

- Occurs when body tissues exposed to excessive levels of T3 & T4

- Effects are due to ↑ BMR
- Main causes are –

1. Grave's disease
2. Toxic nodular goitre
3. Adenoma (a benign tumor)

Grave's disease

- Also called Grave's thyroiditis
- Accounts for 75% cases of hyperthyroidism
- Any age, most common between 30-50 yrs
- It is an autoimmune disorder – antibody mimics the effects of TSH; increased release of T3, T4, goitre, exopthalmos

Exopthalmos

- Protrusion of eye balls – gives appearance of scaring
- Due to excess fat & fibrous tissue deposition behind eyes

Toxic nodular Goitre

- One or two nodules of gland already affected by goitre become active & secrete excess T3 & T4
- Cause effects of hyperthyroidism
- Women > Men
- No exopthalmos
- Arrhythmias & cardiac failure more common

Hypothyroidism

- Prevalent in older adults
- 5 times more in females than males
- Due to deficiency in T3 & T4 – abnormally low metabolic rate
- Accumulation of mucopolysaccharides in subcutaneous tissue causes swelling (non-pitty edema) of face, hands, feet & eyelids (myxoedema)

- Most common causes

1. Autoimmune thyroiditis
2. Severe iodine deficiency
3. Healthcare interventions (ex: antithyroid drugs, surgical removal of thyroid tissue or ionising radiation)

Autoimmune thyroiditis

- Also called ***Hashimoto's disease***
- More common in women than in men
- Autoimmune condition – antibodies react with thyroglobulin & thyroid gland cells – prevent synthesis & release of thyroid hormones – hypothyroidism
- Sometimes goitre also present

Congenital hypothyroidism

- Profound deficiency or absence of thyroid hormones
- Seen few weeks or months after birth
- Endemic in parts of the world where diet has severe deficiency of iodine – profound impairment of growth & cognitive development – if treatment does not begin early, leads to permanent cognitive impairment
- Affected individual – short limbs, large protruding tongue, coarse dry skin, poor abdominal muscle tone

Simple Goitre

- Enlargement of thyroid gland without signs of hyperthyroidism
- Caused by relative lack of T3 & T4 – stimulate TSH secretion – hyperplasia of thyroid gland
- Causes –

1. Persistent iodine deficiency (endemic goitre)
2. Genetic abnormality affecting T3, T4 synthesis
3. Iatrogenic factors, ***ex:*** antithyroid drugs, surgical removal of excess thyroid tissue

Tumors

- Malignant are rare
- Benign – single adenoma

Functions

1. Secrete parathyroid hormone (PTH, parathormone) – regulates blood calcium levels - ↓ Ca^{2+} levels in blood, PTH secretion ↑
2. PTH secretion increases blood calcium levels – release stored calcium in bone by stimulation of osteoclasts, increase calcium reabsorption from renal tubules
3. PTH & calcitonin – act in complementary manner – maintain blood calcium levels

- Calcium essential for

- ***Muscle contraction***
- ***Transmission of nerve impulse***
- ***Blood clotting***
- ***Normal action of many enzymes***

Disorders

Hyperparathyroidism

- Characterised by high blood calcium levels (hypercalcaemia)
- Caused by benign parathyroid tumor – secretes high levels of PTH – release calcium ions from bones – increase blood calcium levels
- ***Effects –***

1. Polyuria & polydipsia
2. Formation of renal calculi
3. Anorexia & constipation
4. Muscle weakness
5. General fatigue

Hypoparathyroidism

- PTH deficiency causes hypocalcaemia – abnormally low blood calcium
- Rarer
- Causes – damage to or removal of glands during thyroidectomy, ionising radiation, development of autoantibodies & congenital abnormalities
- ***Effects –***

1. Tetany
2. Anxiety
3. Paraesthesia
4. Grandmal seizures
5. Cataracts & brittle nails

Tetany

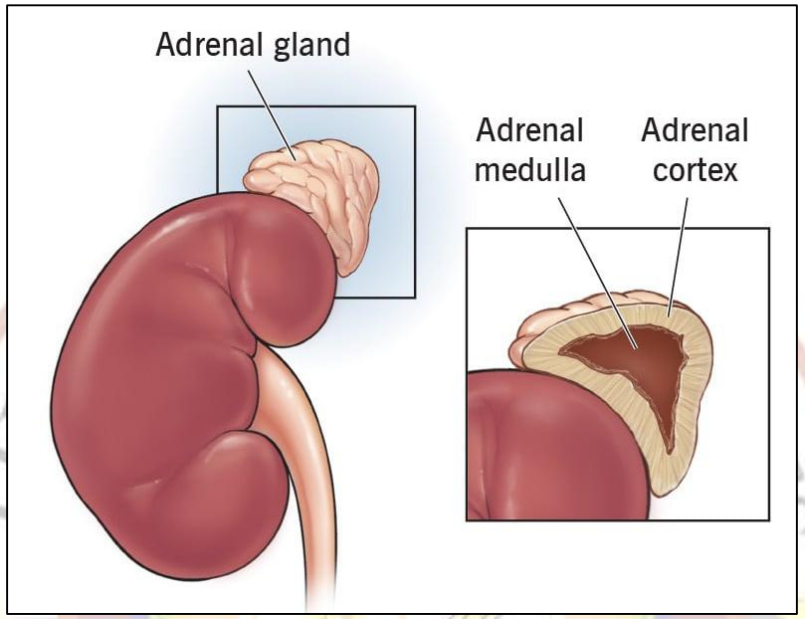
- Caused by hypocalcaemia
- Decrease blood calcium – increase excitability of peripheral nerves
- Very strong painful spasms of skeletal muscles – characteristic inwards bending of hands, forearms & feet
- In children – also laryngeal spasm & seizures

ADRENAL GLANDS

- 2 adrenal/ suprarenal glands situated on the upper pole of each kidney
- 4 cm long & 3 cm thick
- Glands composed of 2 parts – have different structures & functions

- Outer layer – Cortex – essential to life
- Inner core – Medulla

- Glands play an important role in stress response
- Short-term stress – sympathetic nervous system & adrenal medulla – activation of fight or flight responses
- Long-term stress – ACTH – glucocorticoids & mineralocorticoids from adrenal cortex – more prolonged response to stress

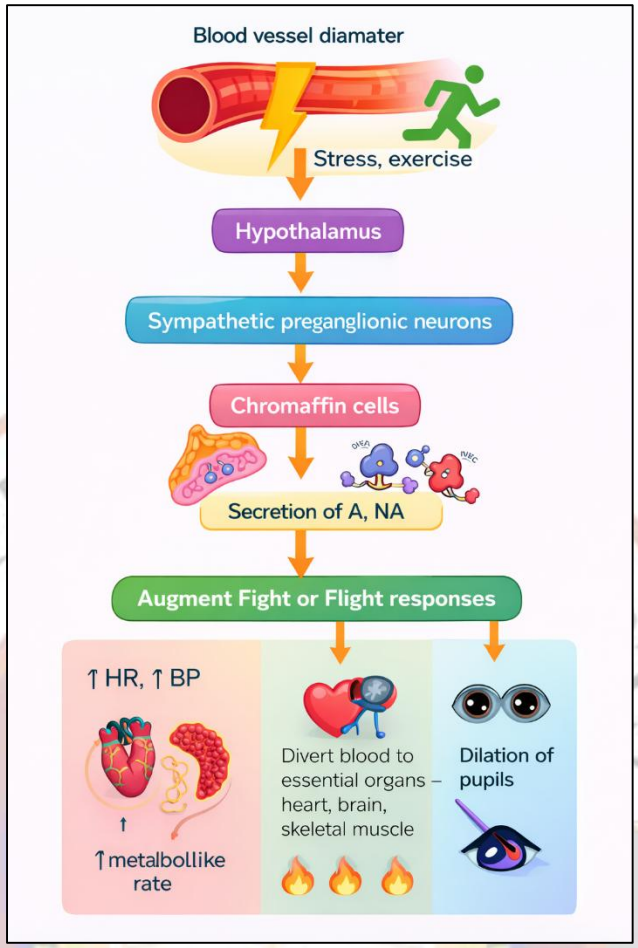


Adrenal Medulla

- Inner region of adrenal gland, a modified sympathetic ganglion of ANS
- Develops from nervous tissue in embryo
- Chromaffin cells of medulla secretes hormones – A & NA
- Cells are innervated by sympathetic preganglionic neurons of ANS
- 80% A & 20% NA

Control of secretion of hormones

- Sympathetic preganglionic neurons release Ach – stimulates secretion of Adrenaline, Noradrenaline
- Adrenaline – greater effect on heart & metabolic processes
- Noradrenaline – influence on blood vessel diameter



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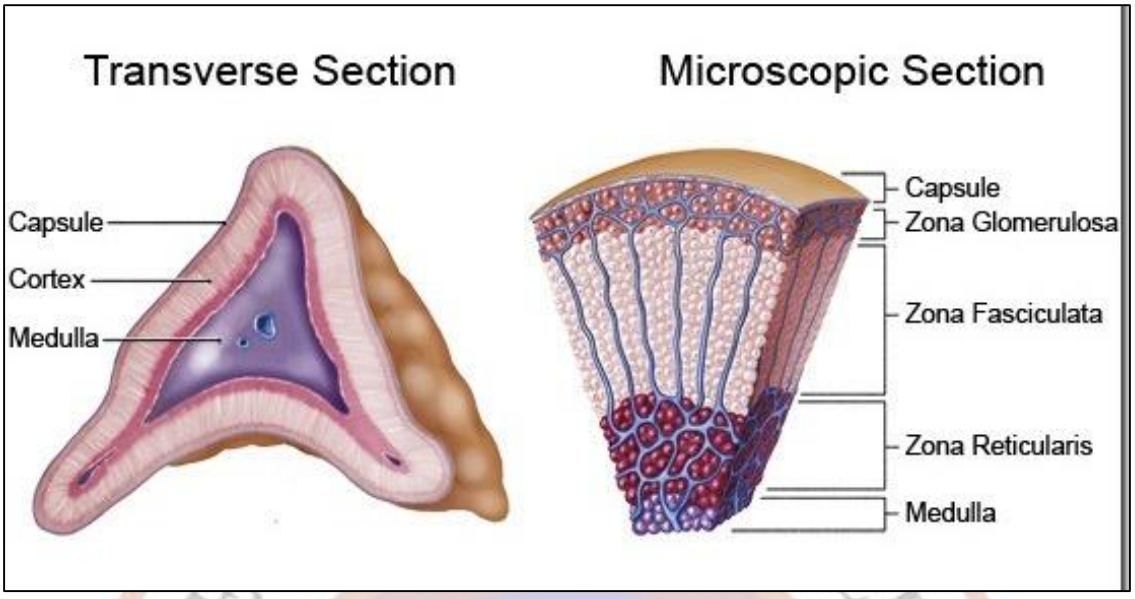
Adrenal Cortex

- Subdivided into 3 zones – produces 3 types of steroid hormones from cholesterol – collectively called adrenocorticoids (corticosteroids)
- Outer zone – ***zona glomerulosa***
- Middle zone – ***zona fasciculata***

- Inner zone – ***zona reticularis*** Zona glomerulosa – secrete *mineralocorticoids* – maintain mineral homeostasis
- Zona fasciculata – secrete *glucocorticoids* (primarily cortisol, affects glucose homeostasis
- Zona reticularis – small amounts of weak androgens (*gonadocorticoids*)

Mineralocorticoids

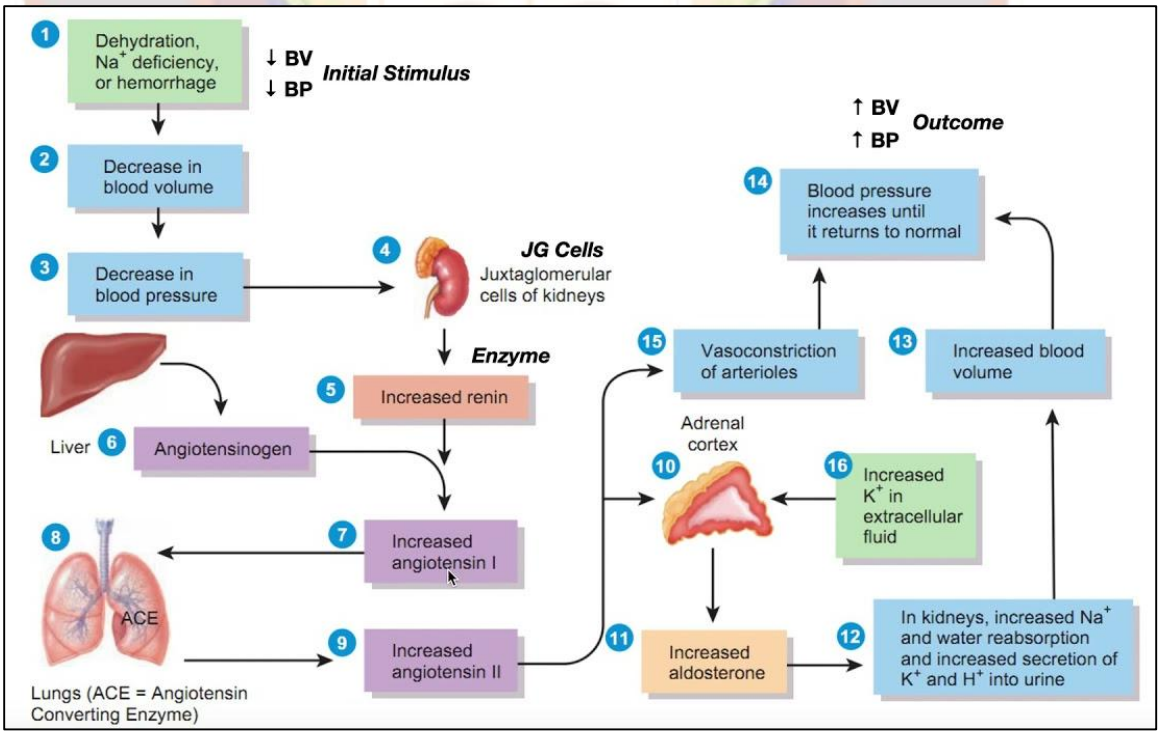
- Aldosterone – major
- Mainly – water & electrolyte balance



1. Na+, K+ ions help adjust the blood volume & blood pressure
2. Promote excretion of H+ ions in urine
3. Promote Na+ reabsorption, K+ excretion, water retention

- Aldosterone secretion is controlled by Renin-Angiotensin-Aldosterone (RAAS) pathway

Renin Angiotensin Aldosterone (RAAS) Pathway



Glucocorticoids

- Regulate metabolism & resistance to stress
- 3 hormones

1. *Cortisol* – most abundant (95%)
2. *Corticosterone*
3. *Cortisone*

Effects

Protein breakdown – release of amino acids – synthesis of new proteins & ATP production

Glucose formation – by glycogenolysis & gluconeogenesis

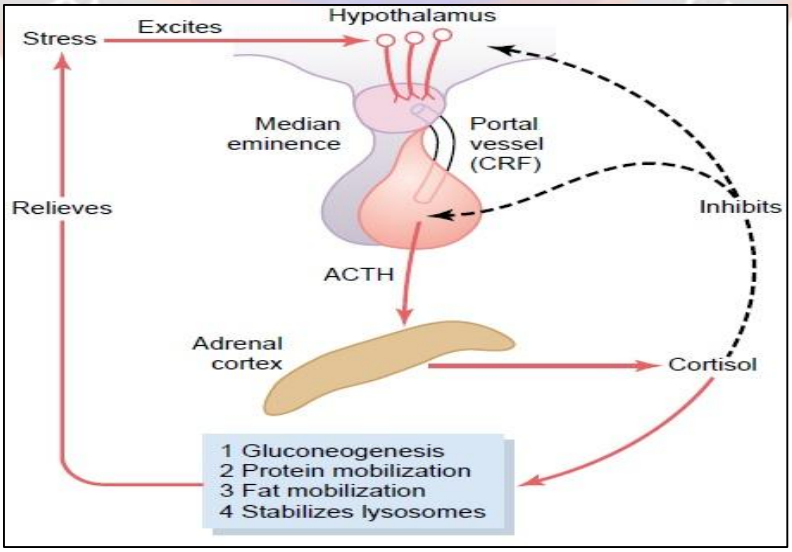
Lipolysis – breakdown of triglycerides into fatty acids & glycerol - ↑ free fatty acids in blood

Resistance to stress – combat exercise, fasting, fright, temperature extremes, high altitudes, bleeding, infection, surgery, trauma & disease

Anti-inflammatory effects – inhibit WBC that participate in inflammation, unfortunately slows wound healing; useful in treatment of RA, Asthma

Depression of immune responses – high doses depresses immune responses; used in organ transplantation

- Cortisol secretion shows marked circadian variations – peaks 4 am & 8 am, lowest – midnight & 3 am
- Sleep/ wake pattern changed – takes several days for ACTH/ cortisol secretion to readjust



Androgens/ sex hormones (gonadocorticoids)

- Both males & females secretes small amounts of weak androgens
- Major androgen – **Dehydroepiandrosterone (DHEA)**
- After puberty in males – more androgens from testes
- In females – promote libido (sex drive) & converted to estrogens after menopause
- Also stimulate growth of axillary & pubic hair in boys & girls
- Their secretion is stimulated by ACTH

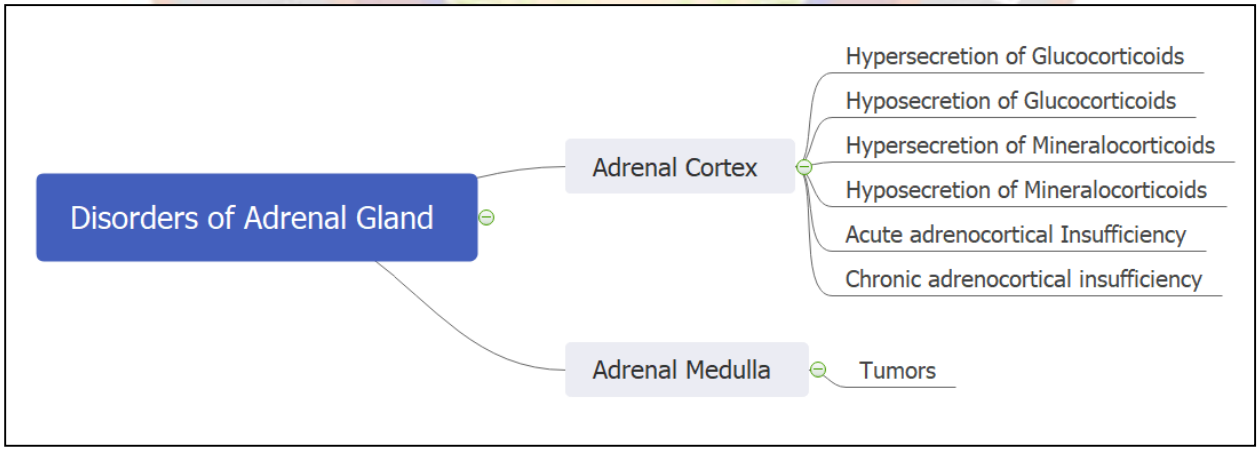
Hypersecretion of Glucocorticoids

- Condition – ***Cushing's syndrome***
- Causes of hypersecretion

1. Hypersecretion of ACTH – most common
2. Prolonged treatment with ACTH or Glucocorticods

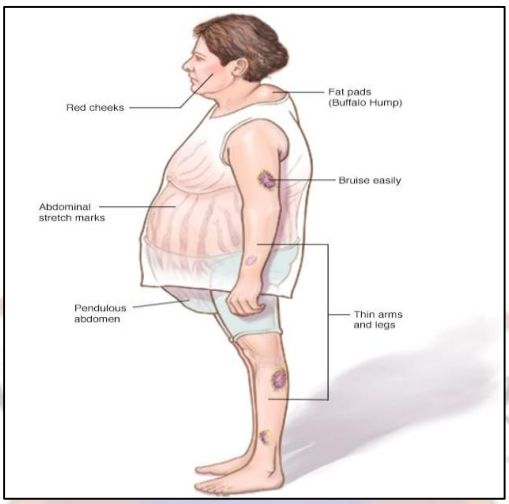
- Hypersecretion exaggerates physiological effects

- Adiposity of face (moon face), neck, abdomen
- Excessive protein breakdown – muscle wasting (limbs)
- Diminished protein synthesis
- Suppression of GH secretion, prevent normal growth in children
- Osteoporosis, kyphosis
- Fractures due to calcium loss from the bones
- Excessive gluconeogenesis – leads to diabetes mellitus
- Depression of immune responses



- Susceptibility to infection
- Impaired collagen production – stretch marks
- Insomnia, excitability, euphoria, depression or psychosis
- Hypertension due to salt & water retention
- Menstrual disturbances

- Formation of renal calculi
- Peptic ulceration



Hyposecretion of Glucocorticoids

- ↓ cortisol secretion
- ***Effects –***

1. Diminished gluconeogenesis
2. Low blood glucose
3. Muscle weakness
4. Pallor

- ***Causes –***

1. Primary – due to disease of adrenal cortex
2. Secondary – due to deficiency of ACTH

Hypersecretion of mineralocorticoids

- Excess aldosterone effects kidney function
- Excessive reabsorption of NaCl & water - ↑ Blood Volume & hypertension
- Excessive excretion of K+ - hypokalaemia; leads to

- Cardiac arrhythmias
- Alkalosis
- Syncope – temporary loss of consciousness caused by fall in BP
- Muscle weakness

- Primary hyperaldosteronism – due to excessive secretion of mineralocorticoids
- Secondary hyperaldosteronism – due to overstimulation of normal glands

Hyposecretion of mineralocorticoids

- Hypoaldosteronism – due to failure of kidneys to regulate Na+, K+, water excretion
- Leads to – hyponatraemia, hyperkalaemia, dehydration, low blood volume & low blood pressure

Chronic adrenocortical insufficiency (Addison's disease)

- Destruction of adrenal cortex – hyposecretion of glucocorticoids & mineralocorticoids
- ***Effects***

- Muscle weakness & wasting
- GI disturbances – vomiting, diarrhoea, anorexia
- Increased skin pigmentation, tiredness
- Hypoglycaemia
- Menstrual disturbances, loss of body hair in women
- Electrolyte imbalance, chronic dehydration

Acute adrenocortical insufficiency (Addisonian crisis)

- Sudden severe nausea, vomiting, diarrhoea, hypotension, electrolyte imbalance (hyponatraemia, hyperkalaemia) – severe cases – circulatory collapse
- Occurs when individual with chronic adrenocortical insufficiency is subjected to stress

Disorders of Adrenal Medulla

Tumors

- Most tumors secrete ↑ quantities of hormones
- Consequences –

- hypertension, weight loss, nervousness & anxiety
- Headache, excessive sweating
- Hyperglycaemia, glycosuria
- Constipation

- ***Phaeochromocytoma*** (benign tumor); ***neuroblastoma*** – rare & malignant tumor in infants & children

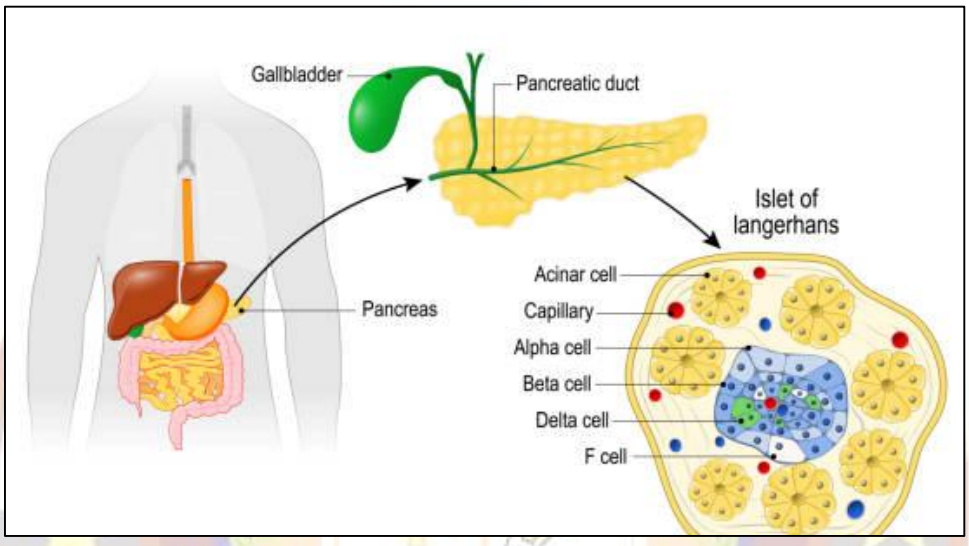
PANCREATIC ISLETS

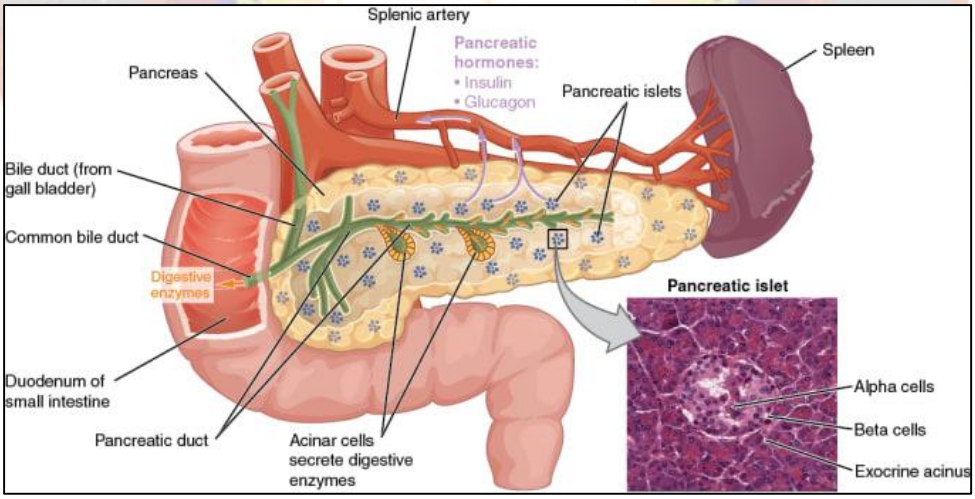
- Pancreas – both exocrine & endocrine gland
- Located in the curve of duodenum
- Only 2% has endocrine function – consists of cluster of cells known as pancreatic islets (islets of Langerhans) scattered throughout exocrine part
- Hormones secreted directly into blood stream

- **Cell types –**

- Each pancreatic islets includes 4 types of hormone secreting cells

1. ***α (alpha/ A) cells*** – secrete glucagon
2. ***β (beta/ B) cells*** – 70% secrete insulin
3. ***δ (delta/ D) cells*** – secrete somatostatin
4. ***F cells*** – secrete pancreatic polypeptide





- Normal blood glucose level – 63-144 mg/ 100 ml
- Blood glucose levels controlled by opposing actions of insulin & glucagon

- Glucagon ↑ blood glucose levels
- Insulin ↓ blood glucose levels

Insulin

- A polypeptide hormone – about 50 AA
- Lowers raised blood nutrient levels, not only glucose but also AA, FAs – promote storage

Actions

- ➢ Activate glucose transporters – stimulate uptake & use of glucose by muscle & connective tissue cells
- ➢ Increase conversion of glucose to glycogen (glycogenesis) – liver & skeletal muscle
- ➢ Uptake of AA by cells – synthesis of proteins

- ➢ Promote synthesis of FAs & storage of fat in adipose tissue (lipogenesis)
- ➢ Decrease glycogenolysis (breakdown of glycogen into glucose)
- ➢ Prevent breakdown of protein & fat and gluconeogenesis

- Insulin secretion is controlled by negative feedback mechanism
- Stimulation – increase in blood glucose after meals, parasympathetic system, GI hormones (gastrin, secretin, CCK), GIP (Glucose dependent insulinotropic peptide) from SI
- Inhibition – sympathetic stimulation, glucagon, adrenaline, cortisol, somatostatin

Glucagon

- Increase blood glucose levels by stimulation of

- Conversion of glycogen to glucose in liver & skeletal muscle (glycogenolysis)
- Gluconeogenesis

- Secretion – low blood glucose levels, exercise, increased sympathetic activity
- Inhibition – somatostatin, insulin

Somatostatin

- Inhibits secretion of both insulin & glucagon
- Inhibits GH from anterior pituitary
- Slow absorption of nutrients from GIT

Pancreatic polypeptide

- Inhibits somatostatin secretion, gallbladder contraction, secretion of digestive enzymes by pancreas

Disorders of the Pancreatic Islets

Diabetes mellitus

- Most common endocrine disorder

- Primary sign – hyperglycaemia – disruption of carbohydrate & fat metabolism
- Cause – complete absence of, relative deficiency of OR resistance to hormone insulin
- Classification

1. Primary – Type 1 & Type 2
2. Secondary – due to pancreatitis, drug therapy, other endocrine disorders etc.
3. Gestational – develop during pregnancy & may disappear after delivery but often recurr in later life

- Attached to roof of 3rd ventricle of brain and connected to it by short stalk containing nerves
- 10 mm long, reddish brown in colour
- Atrophy after puberty and may become calcified in later life
- Secretes melatonin hormone
- Secretion is suppressed by daylight & increased during darkness – highest at night & lowest around midday
- Not fully understood, melatonin is believed to be associated with

1. Coordination of circadian & diurnal rhythms
2. Mood
3. Inhibition of growth & development of sex organs before puberty

- Bilobed, located behind the sternum between the lungs in mediastenum
- Hormones produced are

- Thymosin
- Thymic humoral factor (THF)
- Thymic factor
- Thymopoietin

- Promote maturation of T cells (WBC that destroys microbes & foreign substances) and may retard ageing process