THE ENDOCRINE SYSTEM

- Two body systems are responsible for sending and receiving sensory information and coordinating body responses. These are the *nervous system* and the *endocrine system*. Together, they are sometimes referred to as the **neuro-endocrine system**.

- The **endocrine system** regulates body activities by releasing **hormones** (chemical messengers) into the bloodstream, where they are carried throughout the entire body.

- Hormonal responses may be almost instantaneous (Sudden), or may occur days later. There is a wide variety of hormonal effects.

HORMONE FUNCTIONS

- Regulate the chemical composition and volume of the internal environment (extracellular fluid).
- Help regulate metabolism and energy balance.
- Help regulate contraction of smooth and cardiac muscle fibers and secretion by glands.
- Help maintain homeostasis, despite disruptions, such as infection, trauma, emotional stress, dehydration, starvation, hemorrhage, and temperature extremes.

EXOCRINE & ENDOCRINE GLANDS

- The body contains two kinds of glands:
  - **Exocrine glands** secrete their products into body ducts, which carry the products into body cavities, the lumen of an organ, or the outer surface of the body.
    - Sudoriferous glands, sebaceous glands, mucous glands, and digestive glands.
  - **Endocrine glands** secrete their products (**hormones**) into the extracellular space around the secretory cells. The secretions diffuse into capillaries and are carried throughout the body by the circulatory system.

- The **endocrine system** is composed of the body's endocrine glands. These include:
  - The pituitary,
  - thyroid,
  - parathyroid,
  - adrenal
  - pineal glands
  - Pancreatic islets.

- There are also many organs that have cells which secrete hormones, but are not exclusively endocrine organs.
- These include:
  - The hypothalamus, thymus, pancreas, ovaries, testes, kidneys, stomach, liver, small intestine, skin, heart, and placenta.

HORMONES

- Hormones are a chemical substances that are carried by a cell tissue and initiate specific action.

HORMONES

- Hormones can have very powerful effects, even when present in very low concentrations.
- There are approximately 50 different hormones produced in the human body.
- The specific cells which are affected by a hormone are called **target cells**.
- Hormones influence their target cells by binding to proteins or glycoproteins in the cell membrane called **receptors**.

THE PITUITARY GLAND & hypothalamus

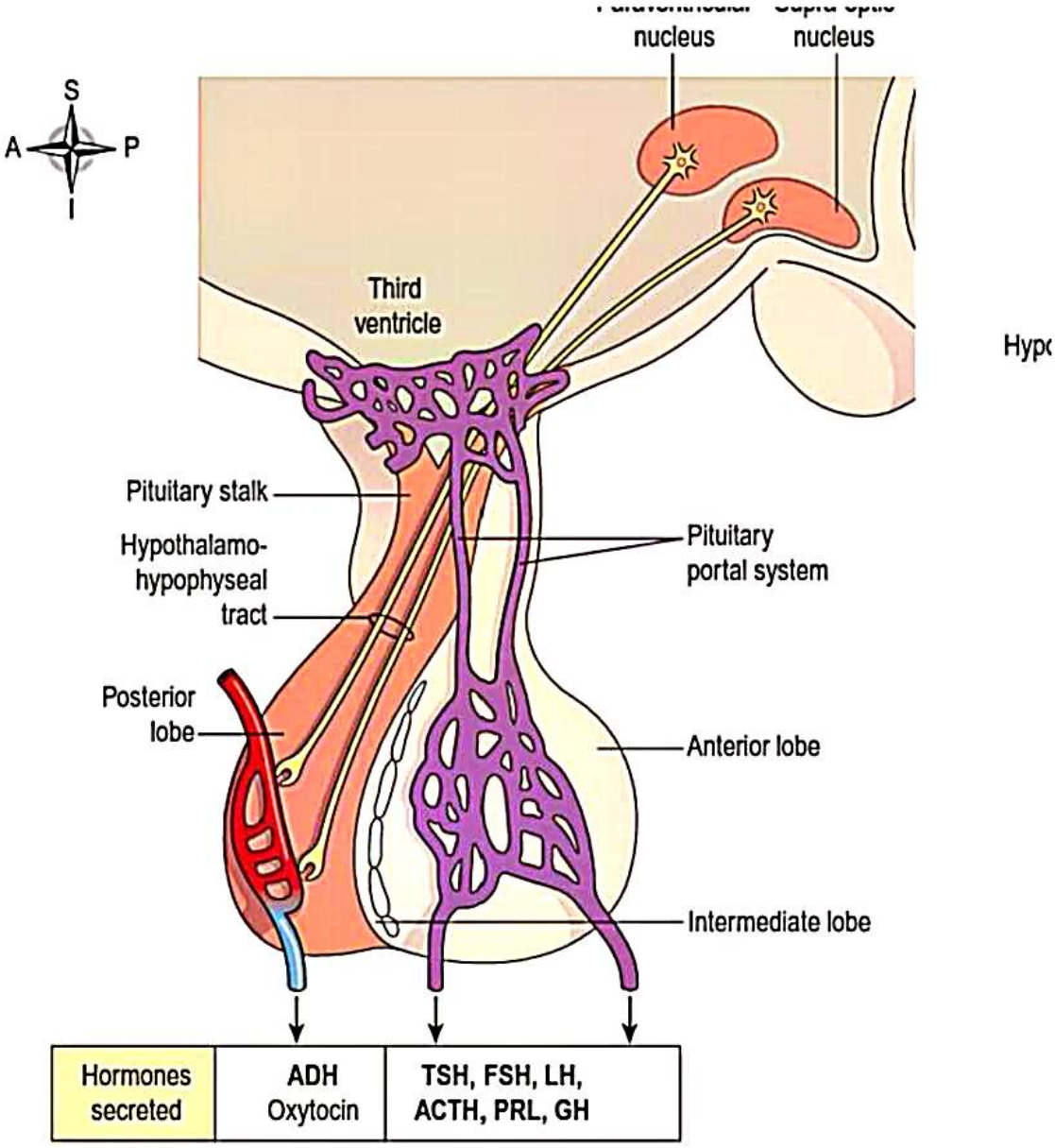
- The **pituitary gland** or **hypophysis** is attached to the **hypothalamus** at the base of the brain.
- The hypothalamus is the major integrating link between the nervous and endocrine systems.

- Although the pituitary gland is sometimes called the "master" endocrine gland.
- Together, the hypothalamus and pituitary gland regulate virtually all aspects of growth, development, metabolism, and homeostasis.

- The pituitary gland can be divided into the **posterior pituitary** and **anterior pituitary**.

- It is the size of a pea, weighs about 500 mg and consists of two main parts that originate from different types of cells.
- The *anterior pituitary* (adenohypophysis) is an upgrowth of glandular epithelium from the pharynx and the *posterior pituitary* (neurohypophysis) a downgrowth of nervous tissue from the brain.

- There is a network of nerve fibres between the hypothalamus and the posterior pituitary.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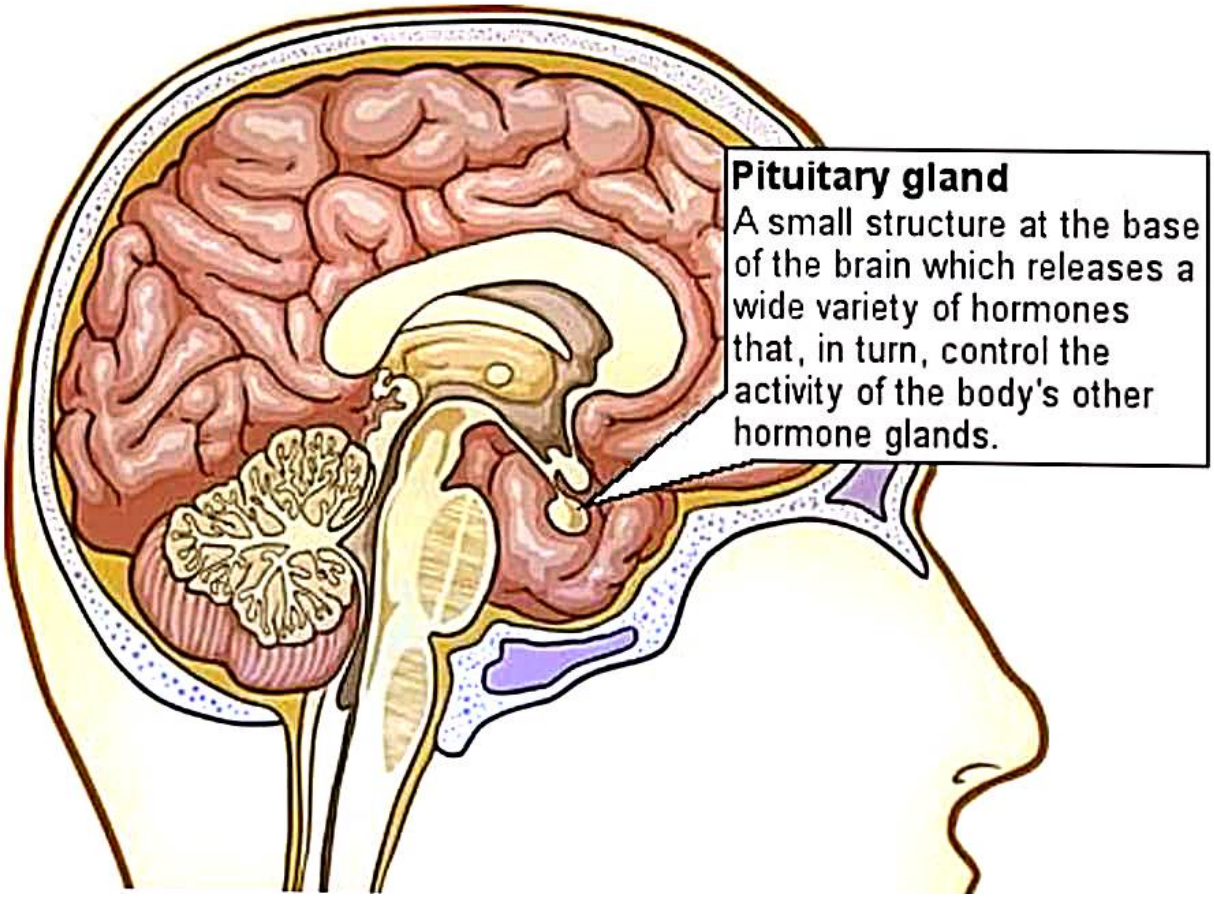
ADH
Oxytocin
TSH, FSH, LH,
ACTH, PRL, GH


Pituitary gland
A small structure at the base of the brain which releases a wide variety of hormones that, in turn, control the activity of the body's other hormone glands.

Blood supply

- **Arterial blood. This is from branches of the internal** carotid artery. The anterior lobe is supplied indirectlyby blood that has already passed through a capillary bed in the hypothalamus but the posterior lobe is supplied directly.

The influence of the hypothalamus on the pituitary gland

- The hypothalamus controls release of hormones from both the anterior and posterior pituitary but in different ways

- **<u>Hormones of the pituitary gland</u>**:

❑ Anterior pituitary = GH
TSH
ACTH
PRL
LH
FSH

❑ Posterior pituitary = Vassopressin or ADH
oxytocin

THE POSTERIOR PITUITARY

- The **posterior pituitary** works as a unit with the hypothalamus.

- Although the posterior pituitary does not synthesize its own hormones, it does store and release **oxytocin (OT)** and **antidiuretic hormone (ADH)** produced in the hypothalamus.

  – OT controls uterine contractions during delivery and milk ejection during breastfeeeding.

  – ADH causes retention of body water, controlling the body's water-balancing mechanism

THE ANTERIOR PITUITARY

- The anterior pituitary secretes hormones that control a wide range of bodily activities.

- The hypothalamus regulates the anterior pituitary by producing **releasing hormones**
- that stimulate release of anterior pituitary gland hormones and **inhibiting hormones** that suppress release of anterior pituitary gland hormones.

- The Anterior pituitary has five princple types of cells which secrete seven major hormones.

ANTERIOR PITUITARY HORMONES

- **GH :** which stimulates general body growth and regulates certain aspects of metabolism.

- **thyroid stimulating hormone (TSH)**, which controls secretions and other activities of the thyroid gland.

- **follicle-stimulating hormone (FSH)** and **luteinizing hormone (LH)**. Together FSH and LH stimulate the secretion of estrogen and progesterone and the maturation of oocytes in the ovaries and the secretion of testosterone and sperm production in the testes.

- **prolactin (PRL),** which initiates milk production in the mammary glands.

- **adrenocorticotropic hormone (ACTH)** and **melanocyte-stimulating hormone (MSH).** ACTH stimulates the adrenal cortex to secrete glucocorticoids. MSH affects skin pigmentation.

Table 9.2 Summary of the hormones secreted by the anterior pituitary gland and their functions

Hormone	Function
Growth hormone (GH)	Regulates metabolism, promotes tissue growth especially of bones and muscles
Thyroid stimulating hormone (TSH)	Stimulates growth and activity of thyroid gland and secretion of T_3 and T_4
Adrenocorticotrophic hormone (ACTH)	Stimulates the adrenal cortex to secrete glucocorticoids
Prolactin (PRL)	Stimulates growth of breast tissue and milk production
Follicle stimulating hormone (FSH)	Stimulates production of sperm in the testes, stimulates secretion of oestrogen by the ovaries, maturation of ovarian follicles, ovulation
Luteinising hormone (LH)	Stimulates secretion of testosterone by the testes, stimulates secretion of progesterone by the corpus luteum

GH: Growth hormone:

- This is the most abundant hormone synthesised by the anterior pituitary.
- It stimulates growth and division of most body cells but especially those in the bones and skeletal muscles.
- Body growth in response to the secretion of GH is evident during childhood and adolescence, and thereafter secretion of GH maintains the mass of bones and skeletal muscles.

- It also regulates aspects of metabolism in many organs, e.g. liver, intestines and pancreas.

- Its release is stimulated by *growth hormone releasing hormone (GHRH) and suppressed by growth hormone release inhibiting hormone (GHRIH), also known as somatostatin,* both of which are secreted by the hypothalamus.

- Secretion of GH is greater at night during sleep and is also stimulated by hypoglycaemia (low blood sugar), exercise and anxiety. Secretion peaks in adolescence and then declines with age.

Thyroid stimulating hormone (TSH)

- The release of this hormone is stimulated by *thyrotrophin releasing hormone (TRH) from the hypothalamus.*

- *It stimulates* growth and activity of the thyroid gland, which secretes the hormones *thyroxine (T4) and tri-iodothyronine* (T3).

- Release is lowest in the early evening and highest during the night.

Prolactin

- This hormone is secreted during pregnancy to prepare the breasts for *lactation (milk production) after childbirth.*

- The blood level of prolactin is stimulated by *prolactin releasing hormone (PRH)* released from the hypothalamus and it is lowered by *prolactin inhibiting hormone (PIH, dopamine)* and by an increased blood level of prolactin.

Gonadotrophins

- Just before puberty two gonadotrophins (sex hormones) are secreted in gradually increasing amounts by the anterior pituitary in response to *luteinising hormone releasing hormone (LHRH), also known as gonadotrophin releasing hormone (GnRH).*

- Rising levels of these hormones at puberty promotes mature functioning of the reproductive organs. In both males and females the hormones responsible
- are:
    - follicle stimulating hormone (FSH)
    - luteinising hormone (LH).

- **Follicle-stimulating hormone (FSH)**
- In female : regulates the development of sex organs in female, development of immature ovarian follicle from the ovary.
- Secretes oestrogen & progesterone during menstrual cycle.
- In male: initiation of spermatogenesis.
- **LH:**
- In females: ovulation, maintaining of corpus luteum and secretion of progesterone.
- In males: testosterone secretion.