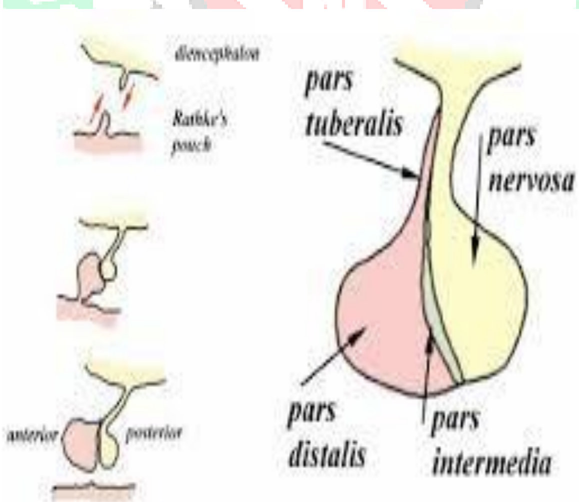
UNIT-4 STRUCTURE AND FUNCTIONS OF PITUITARY GLAND

- **Pituitary gland or hypophysis** is a small endocrine gland with a diameter of 1 cm and weight of 0.5 to 1 g.
- It is situated in a depression called **'sella turcica'**, present in the sphenoid bone at the base of skull and connected with the hypothalamus by the pituitary stalk or hypophyseal stalk.
- Pituitary gland is divided into two divisions:

1. Anterior pituitary or adenohypophysis
2. Posterior pituitary or neurohypophysis.

Both are entirely different in their development, structure and function.

Between the two divisions, there is a small and relatively avascular structure called pars intermedia.



DEVELOPMENT OF PITUTARY GLAND

- Anterior pituitary is **ectodermal** in origin and arises from the pharyngeal epithelium as an upward growth known as **Rathke pouch**.

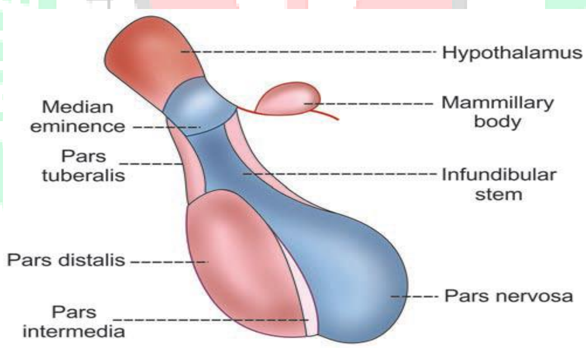
- Posterior pituitary is **neuroectodermal** in origin and arises from hypothalamus as a **downward diverticulum**.
- Rathke pouch and the downward diverticulum from hypothalamus grow towards each other and meet in the midway between the roof of the buccal cavity and base of brain.
- There, the two structures lie close together.

ANTERIOR PITUITARY OR ADENOHYPOPHYSIS

Anterior pituitary is also known as the **master gland** because it regulates many other endocrine glands through its hormones.

Anterior pituitary consists of three parts

1. Pars distalis
2. Pars tuberalis
3. Pars intermedia.



Anterior pituitary has two types of cells

1. Chromophobe cells 2. Chromophil cells.

Chromophobe Cells

Chromophobe cells are not secretory in nature, but are the precursors of chromophil cells.

Chromophil Cells

On the basis of secretory nature chromophil cells are classified into five types:

i. **Somatotropes,** which secrete growth hormone

ii. **Corticotropes,** which secrete adrenocorticotropic hormone

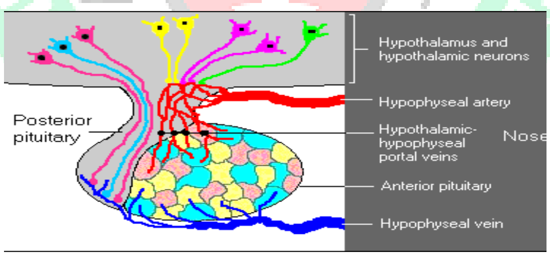
iii. **Thyrotropes,** which secrete thyroid-stimulating hormone (TSH)

iv. **Gonadotropes,** which secrete follicle-stimulating hormone (FSH) and luteinizing hormone (LH)

v. **Lactotropes,** which secrete prolactin.

REGULATION OF ANTERIOR PITUTARY SECRETION

- Hypothalamus controls anterior pituitary by secreting the releasing and inhibitory hormones (factors), which are called **neurohormones.**
- These hormones from hypothalamus are transported anterior pituitary through hypothalamo-hypophyseal **portal vessels.**
- Some special nerve cells present in various parts hypothalamus send their nerve fibers (axons) to median eminence and tuber cinereum. These nerve cells synthesize the hormones and release them into median eminence and tuber cinereum.
- From here, the hormones are transported by blood via hypothalamo-hypophyseal portal vessels to anterior pituitary.



Releasing and Inhibitory Hormones Secreted by Hypothalamus

1. **Growth hormone-releasing hormone (GHRH):** Stimulates the release of growth hormone

2. **Growth hormone-releasing polypeptide (GHRP):** Stimulates the release of GHRH and growth hormone

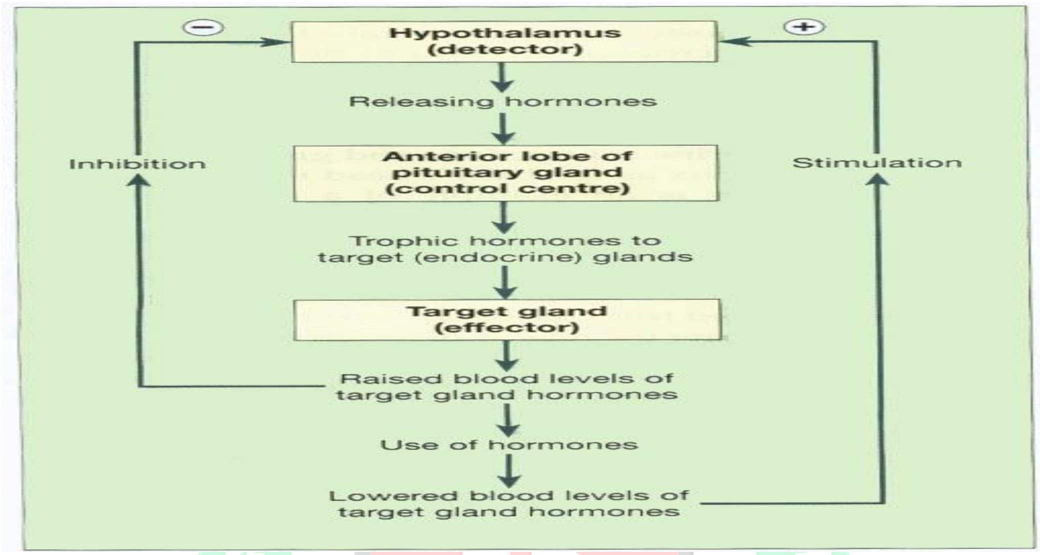
3**. Growth hormone-inhibitory hormone (GHIH) or somatostatin:** Inhibits the growth hormone release

4. **Thyrotropic-releasing hormone (TRH):** Stimulates the release of thyroid stimulating hormone

5. **Corticotropin-releasing hormone (CRH):** Stimulates the release of adrenocorticotropin

6. **Gonadotropin-releasing hormone (GnRH):** Stimulates the release of gonadotropins, FSH and LH

7. **Prolactin-inhibitory hormone (PIH):** Inhibits prolactin secretion. It is believed that PIH is dopamine.



HORMONE SECRETED ANTERIOR PITUTARY:

Six hormones are secreted by the anterior pituitary:

1. Growth hormone (GH) or somatotropic hormone (STH)

2. Thyroid-stimulating hormone (TSH) or thyrotropic hormone

3. Adrenocorticotropic hormone (ACTH)

4. Follicle-stimulating hormone (FSH)

5. Luteinizing hormone (LH) in females or interstitial cell- stimulating hormone (ICSH) in males

6. Prolactin.

GROWTH HORMONE:

Recently, the hormone β-lipotropin is found to be secreted by anterior pituitary.

- Growth hormone is secreted by somatotropes which are the acidophilic cells of anterior pituitary.

- GH is protein in nature, having a single-chain polypeptide with 191 amino acids. Its molecular weight is 21,500.

- Basal level of GH concentration in blood of normal adult is up to 300 g/dL and in children, it is up to 500 ng/dL. Its daily output in adults is 0.5 to1.0 mg.

- Growth hormone is transported in blood by GH-binding proteins (GHBPs).

- Half-life of circulating growth hormone is about 20 minutes. It is degraded in liver and kidney.

- GH is responsible for the general growth of the body.

- Hypersecretion of GH causes enormous growth of the body, leading to **gigantism.** Deficiency of GH in children causes stunted growth, leading to **dwarfism.**

- GH is responsible for the growth of almost all tissues of the body, which are capable of growing. It increases the size and number of cells by mitotic division.

- GH also causes specific differentiation of certain types of cells like bone cells and muscle cells.

GH also acts on the metabolism of all the three major types of foodstuffs in the body, viz. proteins, lipids and carbohydrates.

1. ON METABOLISM

GH increases the synthesis of proteins, mobilization of lipids and conservation of carbohydrates.

a.On protein metabolism

GH accelerates the synthesis of proteins by:

i. Increasing amino acid transport through cell membrane

ii. Increasing ribonucleic acid (RNA) translation

iii. Increasing transcription of DNA to RNA

iv. Decreasing catabolism of protein

v. Promoting anabolism of proteins indirectly

b. On fat metabolism

- GH mobilizes fats from adipose tissue. So, the concentration of fatty acids increases in the body fluids.
- These fatty acids are used for the production of energy by the cells. Thus, the proteins are spared.

c. On carbohydrate metabolism

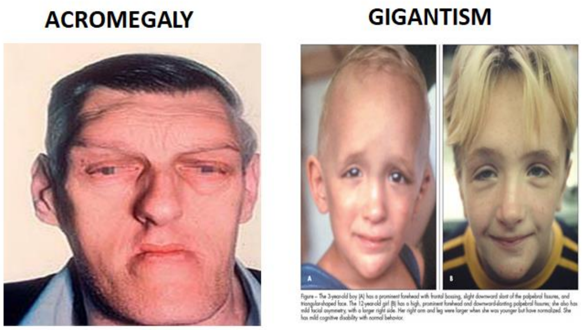
Major action of GH on carbohydrates is the conservation of glucose.

Effects of GH on carbohydrate metabolism:

- Decrease in the peripheral utilization of glucose for the production of energy
- Increase in the deposition of glycogen in the cells
- Decrease in the uptake of glucose by the cells
- Hypersecretion of GH increases blood glucose level enormously.

2. On bones

- In embryonic stage, GH is responsible for the differentiation and development of bone cells. In later stages, GH increases the growth of the skeleton.
- It increases both the length as well as the thickness of the bones.
- Hypersecretion of GH before the fusion of epiphysis with the shaft of the bones causes enormous growth of the skeleton, leading to a condition called **gigantism.**
- Hypersecretion of GH after the fusion of epiphysis with the shaft of the bones leads to a condition called **acromegaly.**



<u>Mode of action:</u>

GH acts on bones, growth and protein metabolism through somatomedin secreted by liver. GH stimulates the liver to secrete somatomedin. Sometimes, in spite of normal secretion of GH, growth is arrested (dwarfism) due to the absence or deficiency of somatomedin.

<u>Somatomedin</u>

Somatomedin is defined as a substance through which growth hormone acts. It is a polypeptide with the molecular weight of about 7,500.

Types of somatomedin

Somatomedins are of two types:

i. Insulin-like growth factor-I (IGF-I), which is also called somatomedin C

ii. Insulin-like growth factor-II.

<u>Somatomedin C</u> (IGF-I) acts on the <u>bones and protein metabolism</u>. <u>Insulin-like growth factor-II</u> plays an important role in the <u>growth of fetus</u>.

<u>REGULATION OF GH</u>

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

GH secretion is stimulated by:

1. Hypoglycemia 2. Fasting 3. Starvation 4. Exercise 5. Stress and trauma 6. Initial stages of sleep.

GH secretion is inhibited by:

1. Hyperglycemia

2. Increase in free fatty acids in blood

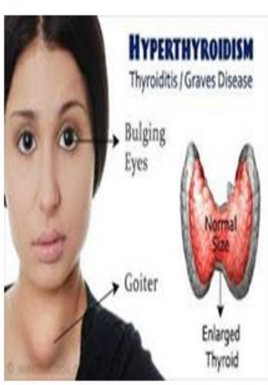
3. Later stages of sleep.

Inhibition of GH secretion occurs by a **negative feedback mechanism** when the blood level rises and also when GHRIH (somatostatin) is released by the hypothalamus.

GHRIH also suppresses secretion of TSH and gastrointestinal secretions, e.g. gastric juice, gastrin and cholecystokinin

<u>THYROID STIMULATING HORMONE (TSH)</u>

- This hormone is synthesised by the anterior pituitary and its release is stimulated by TRH from the hypothalamus.
- It stimulates growth and activity of the thyroid gland, which secretes the hormones thyroxine (T4) and triiodothyronine (T3).
- Release is lowest in the early evening and highest during the night.
- Secretion is regulated by a negative feedback mechanism.
- When the blood level of thyroid hormones is high, secretion of TSH is reduced, and vice versa.
- HYPERSECRETION- Graves disease
- HYPORSECRETION- cretinism(childrens) and myxedema (adult)



GRAVES

CRETINISM

MYXEDEMA

ADRENOCORTICOTROPHIC HORMONE:

- **Corticotrophin releasing hormone (CRH)** from the hypothalamus promotes the synthesis and release of ACTH by the anterior pituitary.
- This increases the concentration of cholesterol and steroids within the adrenal cortext and the output of steroid hormones, especially **cortisol**.
- ACTH levels are highest at about 8 a.m. and fall to their lowest about midnight, although high levels sometimes occur at midday and 6 p.m. This circadian rhythm is maintained throughout life.
- It is associated with the sleep pattern and adjustment to changes takes several days, following, e.g., shift work changes, travel to a different time zone (jet lag).
- Secretion is also regulated by a negative feedback mechanism, being suppressed when the blood level of ACTH rises. Other factors that stimulate secretion include hypoglycaemia, exercise and other stressors, e.g. emotional states and fever.

PROLACTIN:

- This hormone stimulates **lactation** (milk production) and has a direct effect on the breasts immediately after parturition (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.
- After birth, suckling stimulates prolactin secretion and lactation. The resultant high blood level is a factor in reducing the incidence of conception during lactation.
- Prolactin together with oestrogens, corticosteroids, insulin and thyroxine is involved in initiating and maintaining lactation.
- Prolactin secretion is related to sleep, i.e. it is raised during any period of sleep, night or day.
- Emotional stress increases production.

Gonadotrophins

- After puberty two gonadotrophins (sex hormones) are secreted by the anterior pituitary in response to luteinizing hormone releasing hormone (LHRH), also known as gonadotrophin releasing hormone (GnRH).
- In both males and females these are:
  - Follicle stimulating hormone (FSH)
  - Luteinising hormone (LH).
- **In both sexes**

  FSH stimulates production of gametes (ova or spermatozoa).

- **In females**

  LH and FSH are involved in secretion of the hormones oestrogen and progesterone during the menstrual cycle. As the levels of oestrogen and progesterone rise secretion of LH and FSH is suppressed.
- **In males:**

  LH, also called interstitial cell stimulating hormone (ICSH) stimulates the interstitial cells of the testes to secrete the hormone testosterone