**The Pituitary Gland**

*The Pituitary Gland*
It is the master endocrine gland, consists of 3 lobes (anterior, intermediate and posterior) which are more or less separated endocrine glands.
The intermediate lobe is rudimentary in humans.
The anterior and posterior lobes are entirely distinct physiologically.

*The Anterior pituitary (Adenohypophysis)*

**Classification:**
Anterior pituitary gland secretes three hormone groups:

1. **Protein hormone group:**
   a. Growth hormone.
   b. Prolactin.
   c. Placental lactogen (chorionic somatomammotropin).

2. **Glycoprotein hormone group:**
   a. TSH.
   b. LH.
   c. FSH.
   d. Chorionic gonadotropin.

3. **Pro-opio-melano-cortin (POMC) peptide group:**
   a. ACTH.
   b. Melanocyte stimulating hormone (MSH).
   c. β-lipotropin.
   d. Endorphins.
   e. Enkephalin.
Growth hormone “GH”
GH secretion is controlled by 2 hypothalamic hormones:
1. GHRH (growth hormone releasing hormone)
2. GHRIH (growth hormone release inhibitory hormone, “Somatostatin”).

GH is a single poly peptide synthesized by the somatotropes (anterior pituitary acidophilic cells). Secretion of GHRH, and therefore of GH is pulsatile occurring about seven or eight times a day usually associated with the following:
   a) exercise,
   b) onset of deep sleep,
   c) in response to the falling plasma glucose concentration an hour after meals.

Effects of GH
1. Protein metabolism:-
   GH is protein anabolic H. It increases the transport of amino acids into muscle cells.
2. Carbohydrate metabolism :-
   GH antagonizes the effects of insulin, it decreases the peripheral glucose utilization, and increases hepatic glucose production via gluconeogenesis. GH also increases liver glycogen.
3. Lipid metabolism :-
   GH promotes the release of fatty acids and glycerol from adipose tissues and increases circulating fatty acids. It also increases fatty acid oxidation in the liver.
4. Mineral metabolism :-
   It promotes positive Ca, Mg, and P balance, and causes retention of Na, K and Cl. It promotes the growth of long bones at the epiphyseal plate in growing in children and acral growth in adults. It also enhances cartilage formation in children.
5. PRL – like effects:-
   It bind to lactogenic receptors, and has many of PRL effects such as stimulation of mammary gland and lactogenesis.
Pathophysiology:

**GH deficiency**
1. GH deficiency in childhood result in short stature, a condition called *Dwarfism*
2. GH deficiency in adulthood result in lethargy, muscle weakness and increased fat mass.

**GH excess**
1. If occurs before the closure of epiphyseal plate leads to an increase in the growth of long bones, a condition called *Gigantism*.
2. If it occurs after epiphyseal plate closure, then it results in *Acromegaly* in which
3. An increase in bulk of bone and soft tissues causing the characteristic appearance (protruding jaw, enlarged nose, and also enlargement of hands, feet and skull).
   - Excessive hair growth and sebaceous gland secretion.
   - Menstrual disturbances.
   - Impaired glucose tolerance.
**Prolactin “PRL”**

Is a protein hormone secreted by the lactotropes (Pituitary acidophilic cells). PRL secretion is under *predominantly inhibitory control by* Dopamine which is secreted by hypothalamus. However, TRH (Thyrotropin releasing hormone), secreted by hypothalamus may, in some instances, *stimulate PRL secretion*.

It is important during pregnancy & post partum period. Prolactin secretion increases progressively after the eight week of pregnancy probably because of the high estrogen concentration. At term, it may be 10 to 20 times that of non pregnant woman.

**Effects**

*Women:*- Initiation and maintenance of lactation.
*Men:*- not clearly known yet.

**Pathophysiology**

*Women:*-
Excessive RRL (hyperprolactinaemia) causes amenorrhea and galactorrhoea.

**Pathological causes of hyperprolactinaemia:**-
1. A prolactin secreting micro adenoma of the pituitary gland.
2. Failure of hypothalamic inhibitory factors to reach the anterior pituitary gland.
3. Other pituitary tumors.
4. Drugs such as: - estrogen. dopaminergic agonist (phenothiazin, mitoclopramide).
5. Chronic renal failure.
6. Severe primary hypothyroidism.

*Men:*-
Excessive PRL results in erectile dysfunction, impotence and gynaecomastia. Also, it may result in oligospermia.
**Thyroid – Stimulating hormone “ TSH”**

Is a glycoprotein hormone. It’s secretion is controlled by the hypothalamic TRH. It is synthesized by the thyrotropes (basophilic pituitary cells).

**Effects:**

Stimulate the growth of thyroid gland, and the synthesis and release of thyroid hormones (T4 & T3).

The secretion of TSH from the anterior pituitary gland is controlled by:

- Circulating concentration of thyroid hormone.
- thyrotrophin releasing hormone (TRH) which produced In the hypothalamus and stimulate TSH secretion.

**Follicle – Stimulating hormone “FSH” and Luteinizing hormone “LH”**

Interestingly, although there is only one releasing H. for both FSH and LH called LH and FSH releasing H “GnRH” (LHRH, FSHRH) secreted by the hypothalamus, however, LH and FSH can be secreted independently.

FSH and LH are glycoproteins secreted by the gonadotropes (basophilic pituitary cells).

**Effects of LH**

**Women:** Induces ovulation stimulate progesterone production by the corpus luteum, and also, is required for the early maintenance of corpus luteum.

**Men:** Stimulate testosterone production by the Leydig cells of the testis.

**Effects of FSH**

**Women:** Stimulate the maturation of ovarian follicle causing an increase in estradiol production by the granulosa cells of the follicle.

**Men:** FSH is essential for maintenance of spermatogenesis. FSH bind to sertoli cells of Testis, promotes synthesis of ABP “androgen binding protein” which bind to testosterone and transport it to the lumen of seminiferous tubules (the site of spermatogenesis).
Adrenocorticotropic hormone “ACTH”
Is a single poly peptide secreted by the corticotrops basophilic pituitary cells under the control of the hypothalamic CRH (corticotrophin-releasing H.)

Effects:-
It regulate the growth and function of adrenal cortex, and enhances the production of adrenal steroids (glucocorticoids, mineralocorticoids & dehydroepiandrosterone). ACTH also has considerable MSH activity.

β - Lipotropin “β–LPH”
It is found only in the pituitary since it is rapidly converted to γ- LPH and β - endorphin in other tissues.

Effects:- causes lipolysis and fatty acids mobilization, but it physiological role is minimal. It probably serves only as the precursor of β–Endorphin which in turn behave as the precursor of α-endorphin and γ-endorphin.

Endorphins : acts inside the CNS as neurotransmitters and are involved in endogenous pain perception.

γ–Melanocyte – Stimulating hormone “γ-MSH”
They increases pigmentation of the skin and mucous membrane by stimulating melanin synthesis in the melanocytes, and also, causes dispersion of the intracellular melanin granules resulting in skin darkening.

The pituitary in mammals contain 3 MSHs:-
1. α–MSH
2. β ‑MSH
3. γ ‑MSH
γ-MSH is present in high concentration in the intermediate lobe, but is also present in the anterior pituitary. In adults, it appear that neither α - MSH nor β ‑MSH are secreted.
**Hypopituitarism:-**

The anterior pituitary gland has considerable functional reserve. Clinical features of deficiency are usually absent until about 70% of the gland has been destroyed.

**Causes of hypopituitarism:-**

1. Destruction of, or damage to, the anterior pituitary gland or the hypothalamus by a primary or secondary tumor.
2. Infarction most commonly postpartum (Sheehan’s syndrome).
3. Pituitary surgery or irradiation.
4. Less common causes include:
   a. Head injury.
   b. Infection or granulomas.

**The Posterior Pituitary**

*(Neurohypophysis)*

It secretes 2 Hs which are synthesized by the hypothalamus and are transported into the nerve endings in the posterior pituitary, where upon appropriate stimulation, these Hs are released into the circulation:

1. **Oxytocin**

Each of them is a peptide of 9 amino acids.

**Oxytocin**

It's secretion is stimulated by neural impulses resulting from nipple stimulation, vaginal and uterine distension. And by oestrogen. While progesterone inhibit oxytocin production.

**Effects of Oxytocin**

*Women:* - Causes contraction of uterine smooth muscle. Thus, it is used therapeutically for the induction of labour also it stimulate the contraction of myoepithelial cells surrounding the mammary alveoli promoting milk ejection from the breast.

*Men:* - not clearly known yet
HOWEVER, Current evidence suggests that oxytocin is involved in facilitating sperm transport within the male reproductive system and perhaps also in the female, due to its presence in seminal fluid. It may also have effects on some aspects of male sexual behavior.

**Antidiuretic H. (ADH), “Vasopressin”**

ADH secretion is stimulated by:

1. Increased plasma osmolality
2. Physical stress
3. Emotional stress
4. Pharmacological agents:
   - Acetylcholine,
   - Nicotine,
   - Morphine.

**Effects:**
Acts on the distal convoluted tubules and collecting ducts of the kidneys causing water reabsorption by the renal tubules, permitting osmotic equilibrium of the cells of interstitium.

**Pathophysiology**

**Diabetes Insipidus:** Deficiency of ADH or its action leads to Diabetes Insipidus (DI) which is characterized by excretion of large quantities of extremely diluted urine (of very low specific gravity).

DI could be:

1. **Cranial (primary) DI:** due to insufficient ADH secretion.
2. **Nephrogenic (Secondary) DI:** ADH is normally secreted but, either there is inherited defect or acquired damage in ADH receptors.