PITUITARY HORMONES: An Overview

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What are the major sections in the Pituitary Gland?

- Pituitary Gland contain two major sections:
  - **Anterior Pituitary** (Adeno-hypophysis):
    - Glandular Anterior Lobe
  - **Posterior Pituitary** (Neuro-hypophysis):
    - Neuronal Posterior Lobe
- Different mechanisms regulate the hormones produced from each section;
How is the Pituitary function regulated?

• Hypothalamus regulates Pituitary Function;
  • Hypothalamus is connected to Anterior Pituitary via Hypothalamic-Hypophysial Portal System (HHPS):
    • HHPS are capillaries that carries blood from Hypothalamus to Anterior Pituitary and back to Hypothalamus;

• Releasing Hormones produced in the Ventral Hypothalamic Neurons are carried via the Hypothalamic Portal System into the Anterior Pituitary where they stimulate or inhibit the production of Anterior Pituitary hormones;
• Hypothalamus is connected to the Posterior Pituitary via the Hypothalamic Tract;

• **Para-ventricular and Supra-optic nuclei** of the Hypothalamus secrete hormones into the **Posterior Pituitary** for storage and release in the blood;
What are the Anterior Pituitary Hormones?

• Hormones released by Anterior Pituitary;
• There are Six Anterior Pituitary Hormones:
  • Thyroid Stimulating Hormone (TSH or Thyrotropin),
  • Follicle Stimulating Hormone (FSH, Gonadotrophin),
  • Luteinizing Hormone (LH, Gonadotrophin),
  • AdrenoCorticoTropic Hormone (ACTH or Corticotrophin)
  • Growth Hormone (GH)
  • Prolactin (PRL)
What are the primary targets of Anterior Pituitary Hormones?

- **TSH**: Target is **Thyroid Gland**;
- **FSH**:
  - Targets in females: **Follicles in the Ovaries**,
  - Targets in males: **Testes**,
- **LH**:
  - Targets in females: **Follicles**,
  - Targets in males: **Testes**,
- **ACTH**: Targets in **Adrenal Cortex**,
- **GH**: Targets in **most tissues** in the body;
- **PRL**: Targets in **Mammary glands**;
What are the major functions of Anterior Pituitary Hormones?

• **Major functions:**

• **TSH:** Stimulates secretion of Thyroid Hormones;

• **LH:**
  • **In Females:** Triggers Ovulation, increases secretion of Estrogen, Progesterone;
  • **In Males:** Stimulates production of Testosterone;

• **FSH:**
  • **In Females:** Stimulates growth and maturation of Follicle (Oocyte);
  • **In Males:** Stimulates Sperm production and maturation;

• **ACTH:** Causes the secretion of Glucocorticoid;
• **GH:**
  • Stimulates metabolism and growth of body tissues,
  • Stimulates Protein synthesis and Lipolysis,
  • Stimulates production of Insulin-like Growth Factor (IGF) in Liver,
  • **Diabetogenic action:** decreases glucose uptake in cells, thus resulting in increase blood glucose level;

• **PRL:**
  • Stimulates development of mammary glands,
  • Stimulates Lactation in females;
  • Inhibits ovulation by blocking Gonadotropin Releasing Hormone (GnRH),
  • Function is males not well defined;
How are the Anterior Pituitary Hormones regulated?

- Anterior Pituitary hormones are regulated by Hypothalamic Factors (Releasing Hormones) from the Ventral Hypothalamus;
- Fig. 1: Hypothalamic-Anterior Pituitary Axis:
  - Diagrammatic representation of Hypothalamic Factors (Releasing Hormones) and corresponding hormones produced in the Anterior Pituitary;
**Fig. 1: Hypothalamic-Anterior Pituitary Axis:**

<table>
<thead>
<tr>
<th>Hypothalamus</th>
<th>TRH</th>
<th>CRH</th>
<th>GnRH</th>
<th>GHRH</th>
<th>Dopamine</th>
</tr>
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<tbody>
<tr>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
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</table>

<table>
<thead>
<tr>
<th>Anterior Pituitary</th>
<th>TSH</th>
<th>ACTH</th>
<th>LH</th>
<th>FSH</th>
<th>GH</th>
<th>Prolactin</th>
</tr>
</thead>
<tbody>
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<td>+</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Targets</th>
<th>THYROID</th>
<th>ADRENAL CORTEX</th>
<th>GONADS</th>
<th>Liver &amp; Other tissues</th>
<th>Mammary Glands &amp; Other tissues</th>
</tr>
</thead>
</table>
What are the Hypothalamic Factors (Releasing Hormones)?

- Hypothalamic factors or releasing hormones are:
  - Thyrotropin Releasing Hormone (**TRH**);
  - Gonadotrophin Releasing Hormone (**GnRH**);
  - Growth Hormone Releasing Hormone (**GHRH**);
  - Corticotrophin Releasing Hormone (**CRH**);
  - Dopamine (**DA**) or Prolactin Inhibitory Factor (**PIF**);
  - Somatostatin (**SS**);
What are the functions of the Hypothalamic Factors (Releasing Hormones)?

• With the exception of Prolactin, the hypothalamic factors enhances secretion of Pituitary Hormones;

• Specific functions are as follows:
  • **TRH**: Induces secretion of **TSH** and **Prolactin**;
  • **GnRH**: Induces secretion of **LH** and **FSH**;
  • **GHRH**: Induces secretion of **GH**;
  • **Gherelin**: Peptide hormone released from epithelial cells lining the fundus of the stomach acts on the Anterior Pituitary to **enhance** secretion of **GH**;
• **CRH**: Induces production of Proopiomelanocortin (POMC),
  • POMC is then hydrolyzed to ACTH, gamma-MSH and beta-Lipotrophins,
• **Dopamine or Prolactin Inhibitory Factor (PIF)**:
  • Inhibits release of Prolactin;
• **Somatostatin (SS)**: Inhibits release of GH, TSH;
What are the major classes of Anterior Pituitary Hormones and how are they related?

• **Three** major classes (categories) of Anterior Pituitary Hormones:

• **Glycoprotein Hormones:**
  • They contain alpha-subunits and beta-subunits,
  • Alpha-subunits are similar,
  • Beta-subunits have hormonal activity;

• **Growth Hormone –Related Hormones (GHRH):**
  • GH is a polypeptide,
  • GH is homologous with Prolactin and Human Placental Lactogen

• **Corticotrophin-related Hormones:**
  • They are components of Proopiomelanocortin (POMC);
What hormones are in the Glycoprotein class?

• Hormones in the Glycoprotein class are:
  • LH,
  • FSH,
  • TSH,
  • Human Chorionic Gonadotrophin (hCG) – from Placenta;
What are the hormones in the GHRH class?

Hormones in the GHRH class include:

- GH,
- Prolactin (PRL),
- Human Placental Lactogen (HPL) – from Placenta
- Insulin-like Growth Factor (IGF) – from Liver;
What are the hormones in the CRH class?

- Hormones in the CRH class are:
  - ACTH,
  - MSH,
  - Endorphins,
  - Enkephalins,
  - Lipotrophins;
What factors affect secretion of Growth Hormone?

• Secretion of GH can be enhanced by:
  • GHRH,
  • Somatostatin;
  • Sleep, Stress, Exercise,
  • Starvation,
  • Hypoglycemia;

• Secretion of GH can be suppressed by:
  • GH (Negative Feedback control)
  • IGF
  • Obesity,
  • Hyperglycemia;
What mechanism regulates secretion of Growth Hormone?

• GH is regulated by Negative Feedback Mechanism

• Fig 2:
  • Diagrammatic representation of Negative Feedback mechanism for regulation of GH secretion;
  • Hypothalamus – Anterior Pituitary – Axis for GH
  • Role of Gherelin and Somatostatin are indicated in the diagram;
Fig. 2: Hypothalamus – Anterior Pituitary – Axis for GH

- Hypothalamus
  - GHRH
    - +
    - Anterior Pituitary
      - +
      - GH
        - +
        - Liver
          - +
          - IGF-1 (Somatomedin C)
            - +
            - Somatostatin
              - +
              - Gherelin
                - +
Briefly explain the regulation of GH secretion (Fig. 2)

- Hypothalamus secretes GHRH,
- GHRH acts on Anterior Pituitary to produce GH,
- GH acts on Liver to produce Somatomedins peptides;
  - Insulin-like Growth Factor-1 (IGF-1) called Somatomedin C is the major factor produced;
  - Gherelin, from stomach also stimulates GH secretion;
- High levels of IGF-1 and GH stimulate production of Somatostatin in the Hypothalamus,
- Somatostatin inhibits the secretion of GH;
- High plasma levels of IGF-1 exert Negative Feedback on Anterior Pituitary to modify action of GHRH and to inhibit secretion of GH;
What factors that affect secretion of Prolactin?

• Secretion of Prolactin can be **enhanced** by:
  • TRH,
  • Dopamine Antagonists,
  • Breast-feeding,
  • Pregnancy,
  • Stress,

• Secretion of Prolactin can be **suppressed** by:
  • Dopamine (PIF),
  • Dopamine Agonists,
  • Prolactin (Negative Feedback control),
  • Somatostatin,
What are the Posterior Pituitary Hormones?

- Posterior pituitary produces two polypeptide hormones;
  - **Arginine Vasopressin (AVP)**
    - Formally called Anti-Diuretic Hormone (ADH);
  - **Oxytocin**;
What are the functions of Posterior Pituitary Hormones?

- Functions of Posterior pituitary hormones:
  - Arginine Vasopressin (AVP):
    - Increases Aquaporins on distal tubules and collecting ducts in Kidneys;
      - Action causes Reabsorption of water via distal tubules and collecting ducts;
    - Causes constriction of Vascular Smooth Muscle;
  - Oxytocin:
    - Induces contraction of Uterus;
    - Increases Milk production by inducing contraction of mammary glands;
What factors affect the secretion of Oxytocin?

• Oxytocin secretion is regulated by several factors:
  • Secretion is regulated via the Neuro-endocrine reflex arc initiated by suckling;
  • Dilation of the Cervix,
  • Breast-feeding,
What factors affect the secretion of Arginine Vasopressin?

- Factors that causes **increase secretion** of AVP:
  - Increased Plasma Osmolality (sensed by Hypothalamic Osmo-receptors),
  - Reduction in blood volume (sensed by Cardiac Baro-receptors),
  - Reduction in blood pressure,
  - Stress,
  - Hypoglycemia,
  - Nausea,
  - Pain,
Factors that causes decrease secretion of AVP:

• Decrease Plasma Osmolality,
• Release of Atrial Natriuretic Peptide (ANP),
• Alpha-Agonists,
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