



Hypothalamo-Pituitary axis and regulatory mechanism

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ENDO Physiology

Objectives



Structure of pituitary gland

- Anterior pituitary cell types and hormones.
- Posterior pituitary cell types and hormones.



Hypothalamic control of pituitary gland:

- Hypothalamo-hypophyseal portal system.
- Hypothalamo-hypophyseal tract.



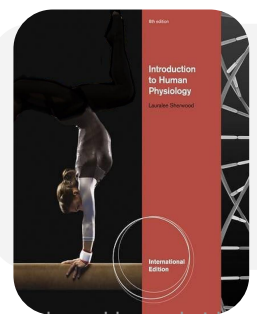
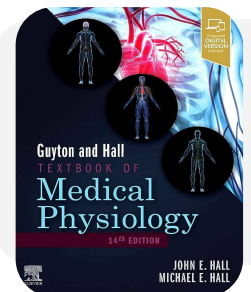
Feedback mechanisms:

- Positive feedback.
- Negative feedback.



Resources

Only ENDO chapters included



sherwood-human-physiology

This lecture was presented by:
Dr. Hana Alzamil - Prof. Abdulmajeed Aldrees

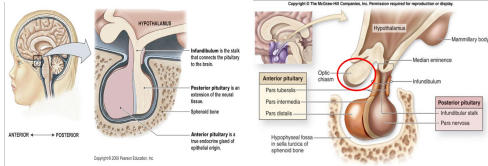
Pituitary Gland

Structure of Pituitary Gland

Pituitary gland (Hypophysis): is a 1 cm gland that weigh 0.5-1g.

❖ Pituitary gland consist of two lobes:

- Anterior (**Adeno**hypophysis) **real gland**
- Posterior (**Neuro**hypophysis) related to hypothalamus
- **Infundibulum** connects the posterior lobe to hypothalamus

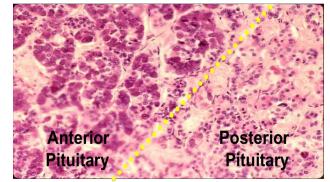


Histology of Pituitary Gland

❖ Anterior pituitary originates from Rathke's pouch (pharyngeal epithelium), which explains the epithelioid nature of its cells.

❖ Posterior pituitary originates from hypothalamus (glial-type cells), which explains the cell type being (neural tissue).

(The Posterior is purely nervous and anterior is nervous and endocrine)



Anterior pituitary contains 5 cell types:

Anterior pituitary gland contains 5 cells which secrete 6 hormones, because 2 hormones are secreted from the same cell (gonadotrophs)

Somatotrophs: GH 40%

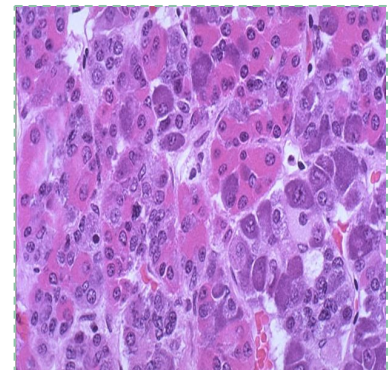
Gonadotropes: LH & FSH

Thyrotrophs: TSH

Lactotrophs: PRL

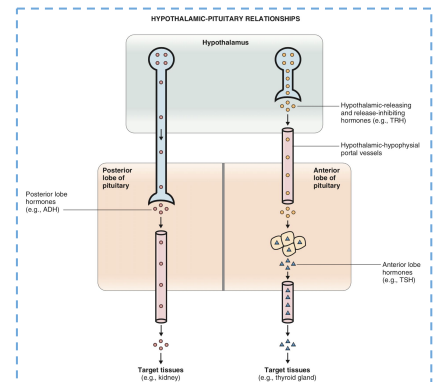
Corticotrophs: ACTH 20%

Trops = Trophs all are correct.



What's the difference between the anterior and the posterior pituitary? *مذكور الكلام من قبل الدكتور باجزاء متفرقة فجمعناه هنا*

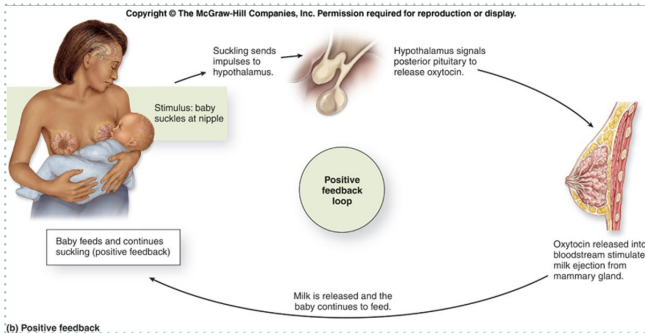
- Both structures secrete hormones, and those secretions are controlled by the hypothalamus, however;
 - The hormones of the Post. Pituitary are synthesized in the hypothalamus.
 - The hormones of the Ant. Pituitary are synthesized in the Ant. Pituitary.
- The relationship between:
 - Hypothalamus and Posterior pituitary= straight-forward Neuronal (important)
 - Hypothalamus and Anterior pituitary= Both Neuronal and Endocrine
- The image >*



Feedback mechanism

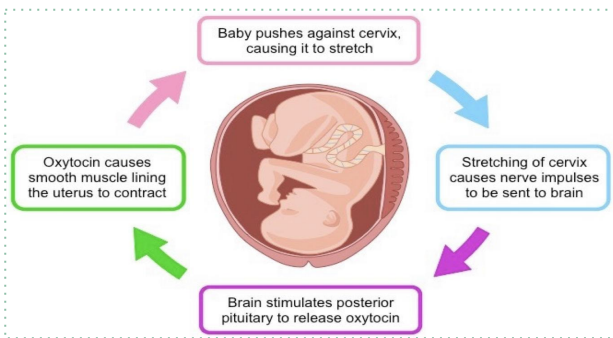
Positive Feedback Mechanism

- Release of hormone A stimulates the release of hormone B.
 - Hormone B **stimulates** further release of hormone A.
- (it's in female slide but males doctor mentioned it)



Doctor's explanation:

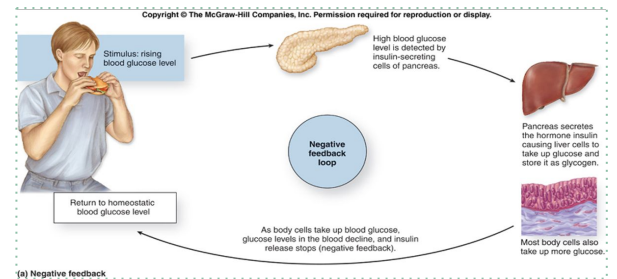
Contraction -> stretch -> contraction -> stretch
 This goes on until the baby is delivered or the uterus ruptures. Oxytocin induces labor -> stimulates uterine contraction



Negative Feedback Mechanism

- Release of hormone A stimulates the release of hormone B.
 - Hormone B **inhibits** the release of hormone A.
- (it's in female slide but males doctor mentioned it)

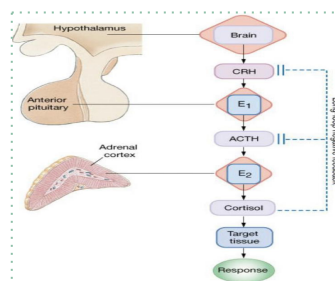
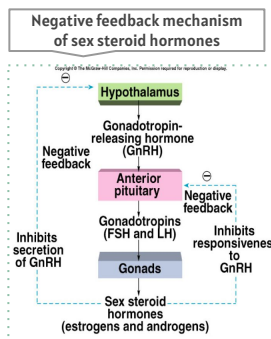
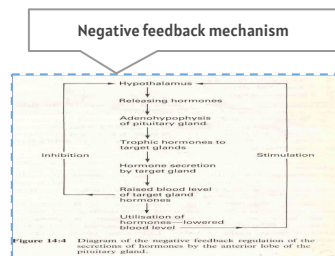
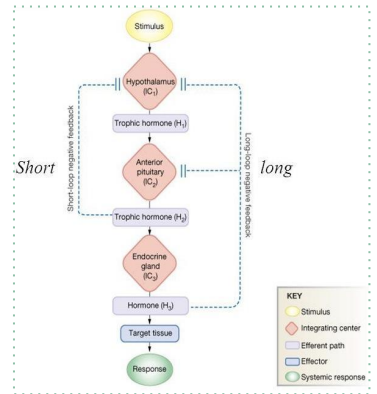
Doctor's explanation: After ingesting a meal, blood glucose level will rise (hyperglycemia) due to absorption of glucose. The pancreas will secrete insulin which will cause glucose utilization -> lowers glucose blood level.



Doctor's explanation:

1. Long loop: Hormone secreted from target gland feedbacks on anterior pituitary and hypothalamus

2. Short loop: Hormone secreted from ant. Pituitary feedbacks on hypothalamus



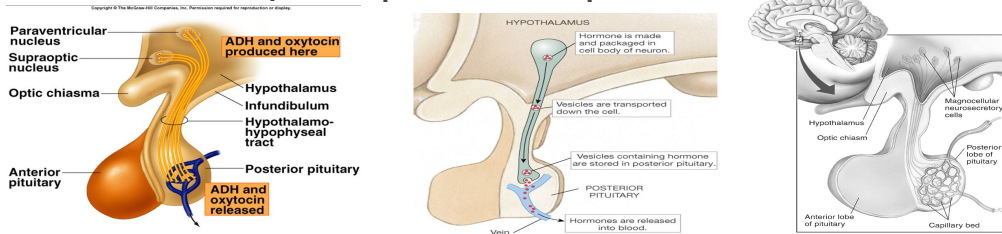
Hypothalamus and its control on pituitary gland

Hypothalamus

- Hypothalamus Composed of number of nerve cells.
- Hypothalamic-Pituitary Axis: coordinate Thyroid gland, adrenal gland & reproductive gland. It also controls growth, milk production and osmoregulation
- **Almost all secretions by the pituitary are controlled by either:**
 - **Hormonal** secretions of hypothalamus **to the portal system to** (the anterior pituitary)
 - **Nervous** signals from hypothalamus **to the neural tract to** (posterior pituitary)

Control of Posterior Pituitary By Hypothalamus (Neurohypophysis)

- Connected by collection of nerve axons + supporting cells and secrete these hormones:
- **Hormones synthesized in the supraoptic (ADH) and paraventricular (oxytocin) nuclei of the hypothalamus** and released in the posterior pituitary. (IMP: ADH is synthesized in supraoptic nuclei, and oxytocin synthesized in paraventricular nuclei)
- **Magnocellular neurons in paraventricular and supraoptic nuclei secrete oxytocin and vasopressin** Another name for ADH **directly into capillaries in the posterior lobe**



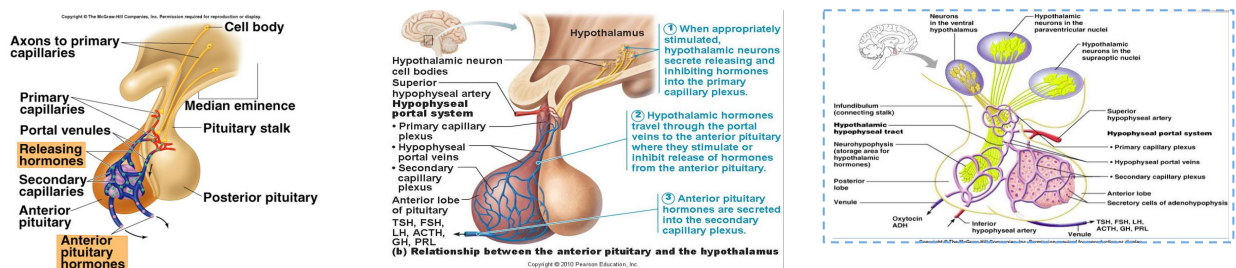
Control of Anterior Pituitary By Hypothalamus (Adenohypophysis)

- Anterior pituitary gland is connected to hypothalamus by portal system: **"hypothalamic-hypophyseal portal vessels"**

1- Special neurons in the hypothalamus synthesize and secrete the hypothalamic releasing and inhibitory hormones that control secretion of anterior pituitary. **Both neural and endocrine control.**

2- Neurons send their nerve fibers to the **median eminence** (extension of hypothalamic tissue into the pituitary stalk).

3- Hormones are secreted to the tissue fluids, absorbed into the **hypothalamic-hypophyseal portal system** and transported to the sinuses of the anterior pituitary.



Hypothalamic Releasing and (OR) Inhibiting Hormones of Anterior Pituitary (BY):

Important

| Hormones | Information | Images |
|---|---|--|
| <p>Growth hormone releasing hormone (GHRH)</p> | <p>GHRH Stimulates release of Growth Hormone. GHIH inhibit release of Growth Hormone.</p> <p><i>Top image:</i> Hypothalamus will secrete GHRH that will act on Anterior pituitary to stimulate secretion of GH. GH will reach bloodstream and reach target tissue to cause its effect. A byproduct of GH is called somatomedin. Majority of GH acts by somatomedin (indirect), and the rest acts direct.</p> <p>1- GHRH inhibits its own secretion from the hypothalamus via an ultrashort loop feedback 2- Somatomedins inhibit secretion of GH by ant. pituitary. 3- Both GH & somatomedin stimulate secretion of somatostatin by the hypothalamus. The overall effect is inhibitory (negative feedback) because somatostatin inhibits GH secretion.</p> | |
| <p>Growth hormone inhibiting hormone (GHIH)</p> <p>Also called Somatostatin</p> | <p><i>Bottom image:</i> Females doctor: just go through it. Males doctor: Hypoglycemia stimulates the release of GH. GH causes gluconeogenesis -> high level of glucose in circulation. In contrast, hyperglycemia leads to decreased secretion of GH.</p> <p>You know why there is this connection? The part of the hypothalamus that causes secretion of GHRH is the same area of the hypothalamus that is sensitive to blood glucose concentration</p> | |
| <p>Thyrotropin releasing hormone (TRH)</p> | <p>Stimulates the release of Thyroid Stimulating Hormone (TSH).</p> <p>It will be secreted by hypothalamus and act on thyrotrophs of anterior pituitary gland to cause secretion of TSH. TSH then acts on thyroid gland to stimulate secretion of T3 and T4 (thyroid hormones). T3 and T4 inhibit secretion of TSH (-ve feedback)</p> | <p>Key: TRH = Thyrotropin releasing hormone TSH = Thyroid-stimulating hormone T₃ = Triiodothyronine T₄ = Thyroxine (Tetraiodothyronine)</p> |

Hypothalamic Releasing and (OR) Inhibiting Hormones of Anterior Pituitary (BY):

Important

| Hormones | Information | Images |
|---|---|--------|
| <p>Corticotropin releasing hormone (CRH)</p> | <p>Stimulates the release of Adrenocorticotrophic Hormone (ACTH).</p> <p>CRH will act on corticotrophs of anterior pituitary gland to secrete ACTH which will work on adrenal cortex and cause secretion of adrenocortical hormones. This will feedback on hypothalamus and Ant pituitary to inhibit further release of hormone. (442)</p> | |
| <p>Gonadotropin releasing hormone (GnRH)</p> | <p>Stimulates the release of two gonadotropic hormones:</p> <ul style="list-style-type: none"> ❖ Luteinizing hormone (LH). ❖ Follicle-stimulating hormone (FSH). <p>GnRH is secreted by the hypothalamus and acts on gonadotrophs of the anterior pituitary gland can cause secretion of LH and FSH that will work on gonads (ovary/testicles).</p> <p>Female Dr: in male Anterior pituitary will secrete LH (work on Leydig cells and secrete Testosterone) and secrete FSH (work on sertoli cells) and both of them stimulate the spermatogenesis.</p> <p>Males Dr: It will be studied in details next block, just appreciate the fact that the target tissue of FSH and LH is the Gonads. (442)</p> | |
| <p>Prolactin inhibitory hormone (PIH)</p> | <p>Also called Dopamine. Inhibit the secretion of Prolactin.</p> <p>There are two regulatory pathways from hypothalamus: 1) inhibitory via dopamine and 2) stimulatory via TRH. In persons who are not pregnant or lactating, prolactin secretion is tonically inhibited by dopamine (PIF) from the hypothalamus. The inhibitory effect of dopamine dominates and overrides the stimulatory effect of TRH.</p> <p>الدوبامين تاثيره قوي جدا فلما يكون موجود ماراح يعطينا برولاكتين لانه ضاغط على ال lactotrophs ومسوي inhibition. مجرد مايروح الدوبامين راح يصير فيه stimulation و راح تزداد عندنا كمية البرولاكتين بكثره.</p> <p>main stimulus of prolactin secretion is limitation of dopamine تاثيره اقوى compared to TRH (442)</p> | |



Clinical Application

What will happen if pituitary gland is removed from its normal position and transplanted to other part of the body?/ "cut"?

- A) Release of all hormones will stop.
- B) Release of some hormones will decrease to very low levels.
- C) Release of some hormones will increase.

Answer: both the B and C answer are correct. All Ant. Pituitary hormones will not be released except for Prolactin, because the PIF will not be released (no inhibition leads to stimulation), and thus it'll increase.

Summaries

Table 9-2 Summary of Endocrine Glands and Actions of Hormones

| Gland of Origin | Hormones* | Chemical Classification [†] | Major Actions |
|-----------------|--|--------------------------------------|---|
| Hypothalamus | Thyrotropin-releasing hormone (TRH) | Peptide | Stimulates secretion of TSH and prolactin |
| | Corticotropin-releasing hormone (CRH) | Peptide | Stimulates secretion of ACTH |
| | Gonadotropin-releasing hormone (GnRH) | Peptide | Stimulates secretion of LH and FSH |
| | Somatostatin or somatotropin release-inhibiting hormone (SRIF) | Peptide | Inhibits secretion of growth hormone |
| | Dopamine or prolactin-inhibiting factor (PIF) | Amine | Inhibits secretion of prolactin |
| | Growth hormone-releasing hormone (GHRH) | Peptide | Stimulates secretion of growth hormone |

Summary of Anterior Pituitary Hormones:

From the slides, Just read it and be familiar with the hormones. They will be discussed in details in the next lectures.

Table 11.6 | Anterior Pituitary Hormones

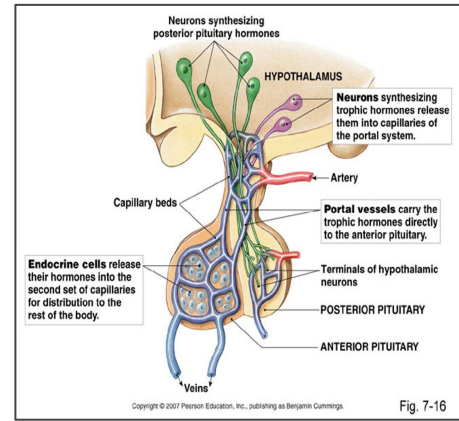
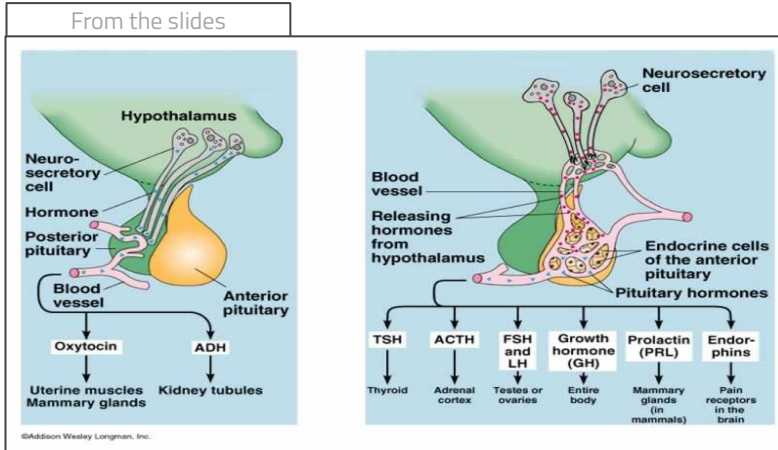
| Hormone | Target Tissue | Principal Actions | Regulation of Secretion |
|------------------------------------|---|--|--|
| ACTH (adrenocorticotropic hormone) | Adrenal cortex | Stimulates secretion of glucocorticoids | Stimulated by CRH (corticotropin-releasing hormone); inhibited by glucocorticoids |
| TSH (thyroid-stimulating hormone) | Thyroid gland | Stimulates secretion of thyroid hormones | Stimulated by TRH (thyrotropin-releasing hormone); inhibited by thyroid hormones |
| GH (growth hormone) | Most tissue | Promotes protein synthesis and growth; lipolysis and increased blood glucose | Inhibited by somatostatin; stimulated by growth hormone-releasing hormone |
| FSH (follicle-stimulating hormone) | Gonads | Promotes gamete production and stimulates estrogen production in females | Stimulated by GnRH (gonadotropin-releasing hormone); inhibited by sex steroids and inhibin |
| PRL (prolactin) | Mammary glands and other sex accessory organs | Promotes milk production in lactating females; additional actions in other organs | Inhibited by PIH (prolactin-inhibiting hormone) |
| LH (luteinizing hormone) | Gonads | Stimulates sex hormone secretion; ovulation and corpus luteum formation in females; stimulates testosterone secretion in males | Stimulated by GnRH; inhibited by sex steroids |



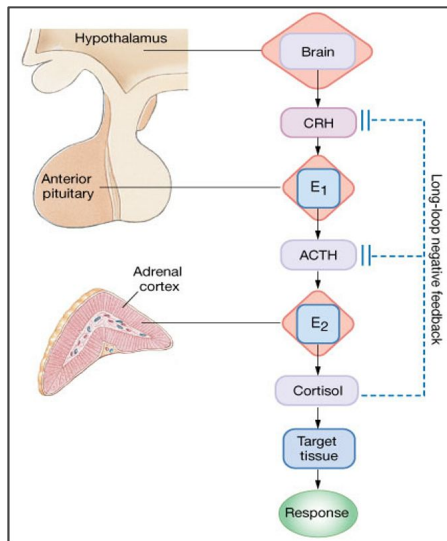
Summary of Hypothalamic Control of Pituitary Gland:

[Click here for a summary of the Ant. Pituitary done by Asma Alamri and Shaden Alobaid!\(442\)](#)

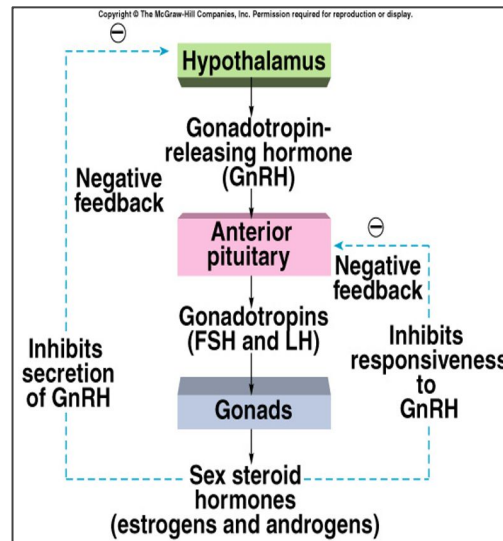
From the slides



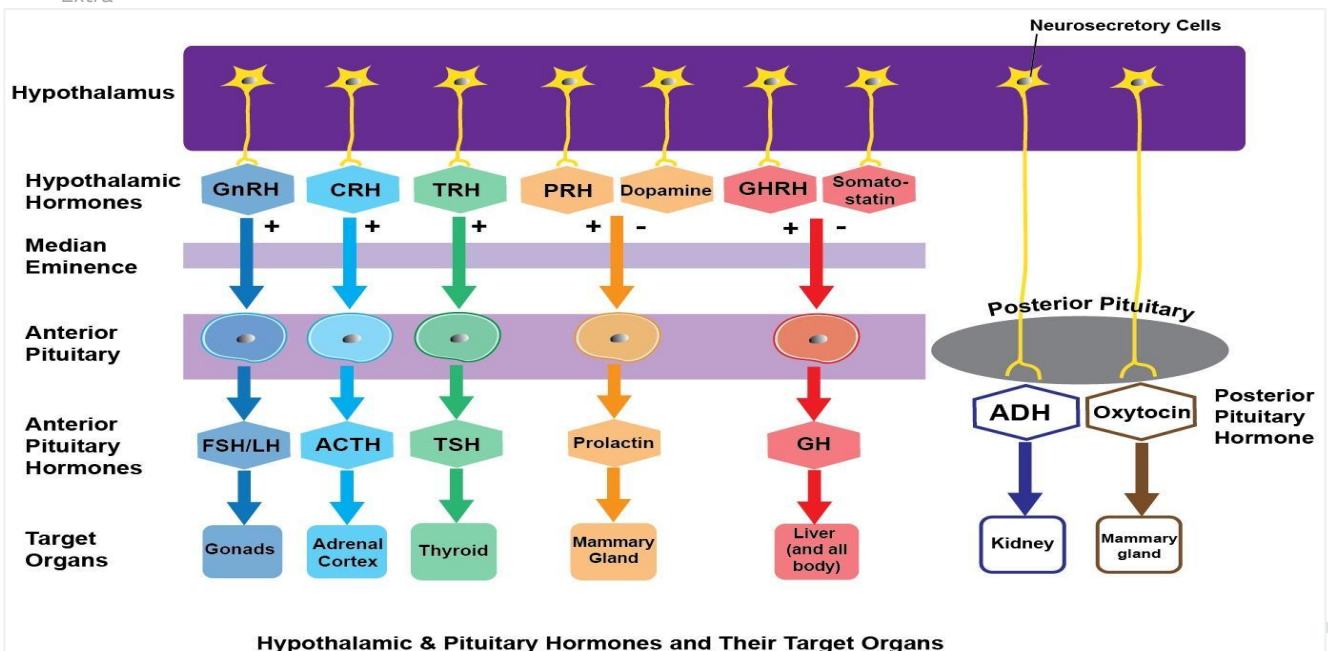
Negative feedback control mechanism of CORTISOL



Negative feedback mechanism of sex steroid hormones



Extra



Hypothalamic & Pituitary Hormones and Their Target Organs



MCQs:

Gonadotropin releasing hormone (GnRH) affect which of the following hormones?

A. Luteinizing hormone

B. Follicle-stimulating hormone

C. Prolactin hormone

D. A+B

Which of the following is secreted in the hypophyseal portal system?

A. ACTH

B. Prolactin

C. Growth hormone

D. CRH

Which one of the following cells produce Luteinizing Hormone?

A. Gonadotropes

B. Somatotrops

C. Lactotrops

D. Thyrotropes

Which one of the following hypothalamic nuclei is connected to the posterior pituitary by the hypothalamo-hypophyseal tract?

A. Preoptic nuclei

B. Para ventricular nuclei

C. Arcuate nuclei

D. Thyrotropes

Which ONE of the following is a gonadotropic hormone?

A. ADH

B. LH

C. ACTH

D. TSH

Which ONE of the following is a regulatory mechanism for prolactin secretion?

A. Inhibition by dopamine secretion

B. Activation of MSH

C. Suppression of somatostatin

D. Stimulation of nipple

Which one of the following coordinates the function between the nervous system and the endocrine system?

A. Adrenal medulla

B. Cerebral cortex

C. Hypothalamus

D. Medulla oblongata

Which one of the following hormones is both synthesized and stored in pituitary gland?

A. ADH

B. GHRH

C. Growth hormone

D. CRH

45 old woman has mass in sella turcica, disturbing the portal vessels that prevent the access of pituitary to the hypothalamus secretions. The secretion rate of which of the following will increase?





A. ACTH

B. Prolactin hormone

C. Growth hormone

D. TSH

SAQ:

-  Q1. List 5 types of cells present in the pituitary gland with their hormones?
-  Q2 What will happen if anterior pituitary gland is removed from its normal position and transplanted to other part of the body?
-  Q3: Explain the difference between the negative feedback & positive feedback mechanisms?
-  Q4: Explain the control of anterior pituitary by hypothalamus?

Answers:

- A1.**
- Somatotrops: GH.
 - Corticotrops: ACTH.
 - Thyrotrops: TSH.
 - Gonadotropes: LH & FSH.
 - Lactotropes: prolactin.
- A2.** Hormones will decrease to very low levels & Release of some hormones will increase.
- A3.**
- Positive feedback: Release of hormone A stimulates the release of hormone B, Hormone B stimulates further release of hormone A.
 - Negative feedback: Release of hormone A stimulates the release of hormone B, Hormone B inhibits the release of hormone A.
- A4.** Special neurons in the hypothalamus synthesize and secrete hypothalamic releasing and inhibitory hormones which are secreted through nerve fibers passing by the median eminence to the tissue fluids absorbed into the hypothalamic-hypophyseal portal system and transported to the sinuses of the anterior pituitary.

Team Leaders



Norah Al Mania



Ayedh Al Qantash



Sadeem Alyahya



Mohammed AlKodhari

Team Members

Remas Al Jeaidi

Faisal Al Showier

Layan Al Ruwaili

Abdullah Al Assiri



Reena Al Sadoni

Yusof Badoghaish

Jana Al Mutlaqah

Zeyad Al Otaibi

Renad M Al Shehri

Aban Basfar

Jouri Al Maymoni

Feras Mazen

Remaz Al Mahmoud

Faisal Al Abdullah

Aljoharah Al Wohaibi

Nazmi A Al Qutub

Shoug Al Khalifa



Nazmi M Al Qutub

Rafan Alhazzani

Osama Al Mashjari

Milaf Al Otaibi

Hamad Al Ziyadi

Shahad Al Zaid

Mohammed Al Qutub

Aseel Al Shehri

Mansour Al Dossari

Almas Al Mutairi

Abdulmalik Al Shammakhi

Afnan Al Ahmari

Waleed Al Rasheed

Rawan Al Qahtani

Faisal Al Ateeq

Ryan Al Ghizzi



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