

# Hypothalamic-Pituitary Axis

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## Page 1. Introduction

- The hypothalamus and pituitary gland form a complex interface between the nervous system and the endocrine system.
- The brain can influence the activity of Neurosecretory cells and hormones can influence the release of other hormones.

## Page 2. Goals/ What You Need to Know

### Goals

- To study the hypothalamic-pituitary axis anatomy.
- To review the hypophyseal portal system.
- To identify sources of endocrine and neural control of the hypothalamic-pituitary axis.
- To review thyroid hormone.

### What You Need to Know

- The difference between a neurotransmitter and a hormone.
- The difference between somatic and autonomic nervous systems.
- The role of the hypothalamus in the control of the autonomic nervous system.
- Also known as the hypophysis.

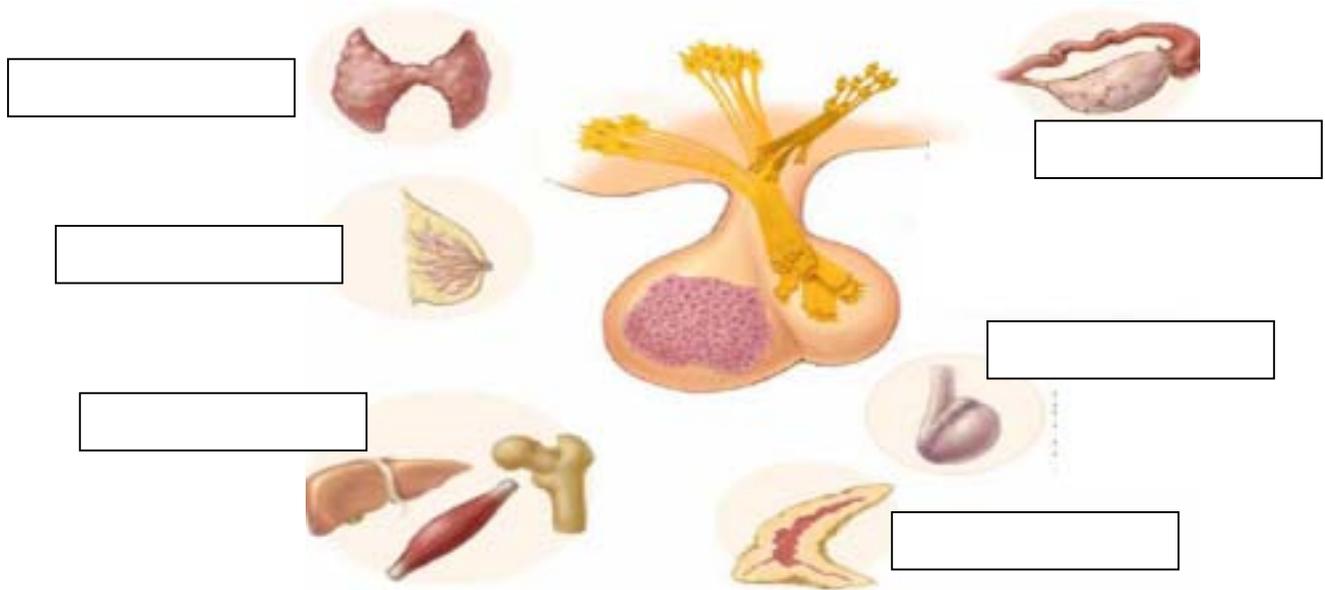
## Page 3. Pituitary Anatomy

- Also known as the hypophysis.
- Divided into the glandular anterior lobe and the neuronal posterior lobe.
  - Anterior lobe is also known as the adenohypophysis.
  - Posterior lobe is also known as the neurohypophysis.
- The pituitary is connected to the hypothalamus via a stalk of tissue called the infundibulum.

### Anterior Pituitary

- The six major anterior pituitary hormones are peptides.
- The Six Major Anterior pituitary hormones are:
  1. Thyroid Stimulating Hormone (TSH or thyrotropin)
  2. Follicle Stimulating Hormone (FSH, a gonadotropin)
  3. Luteinizing Hormone (LH, a gonadotropin)
  4. Adrenocorticotrophic Hormone (ACTH, or corticotropin)
  5. Growth Hormone (GH)
  6. Prolactin (PRL)
- Targets and Functions of the Anterior Pituitary Hormones
  1. TSH – target thyroid gland and stimulates secretion of thyroid hormone (TH).
  2. FSH – targets follicles in the ovaries of females and stimulates growth of follicle and production of estrogen. In males it targets the testes and stimulates sperm cell production.
  3. LH – targets follicle, triggers ovulation and increases secretion of progesterone. In males it stimulates testosterone production.
  4. ACTH – targets the adrenal cortex and causes the secretion of glucocorticoids.
  5. GH - targets most bodily tissues and stimulates metabolism and growth of those tissues.

6. PRL - targets the breasts in females. Stimulates breast development and lactation.
- Of the six anterior pituitary hormones, four directly stimulate other endocrine glands and are known as **tropic hormones**.
  - For each target gland/tissue here fill in the correct anterior pituitary hormone.
  - Also make sure to highlight the four tropic hormones.



- The anterior pituitary gland is connected to the hypothalamus via the hypophyseal portal system.
- Capillaries in the ventral hypothalamus pick up hormones released by hypothalamic neurons and transport them to the capillaries of the anterior pituitary.

### Posterior Pituitary

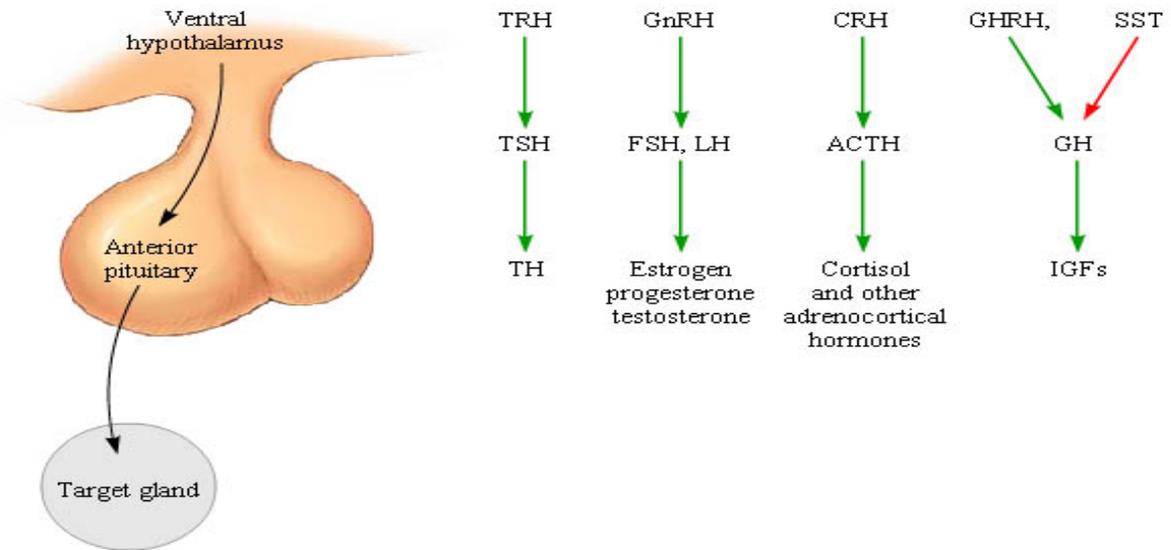
- Is composed primarily of neuronal tissue.
- Is connected to the supraoptic and paraventricular nuclei of the hypothalamus via axons in the infundibulum.
- Stores two major neurohormones for later release.
  1. ADH (vasopressin) – stimulates water reabsorption by kidneys.
  2. Oxytocin – stimulates labor contractions during birth.
- Release of posterior pituitary and hypothalamic hormones is identical to neurotransmitter release by other neurons.
- Molecules that function as hormones in the hypothalamic-pituitary axis are often neurotransmitters, neuromodulators, or paracrines in other places in the body.

### **\*\*Now is a good time to go to the quiz questions #1&2.**

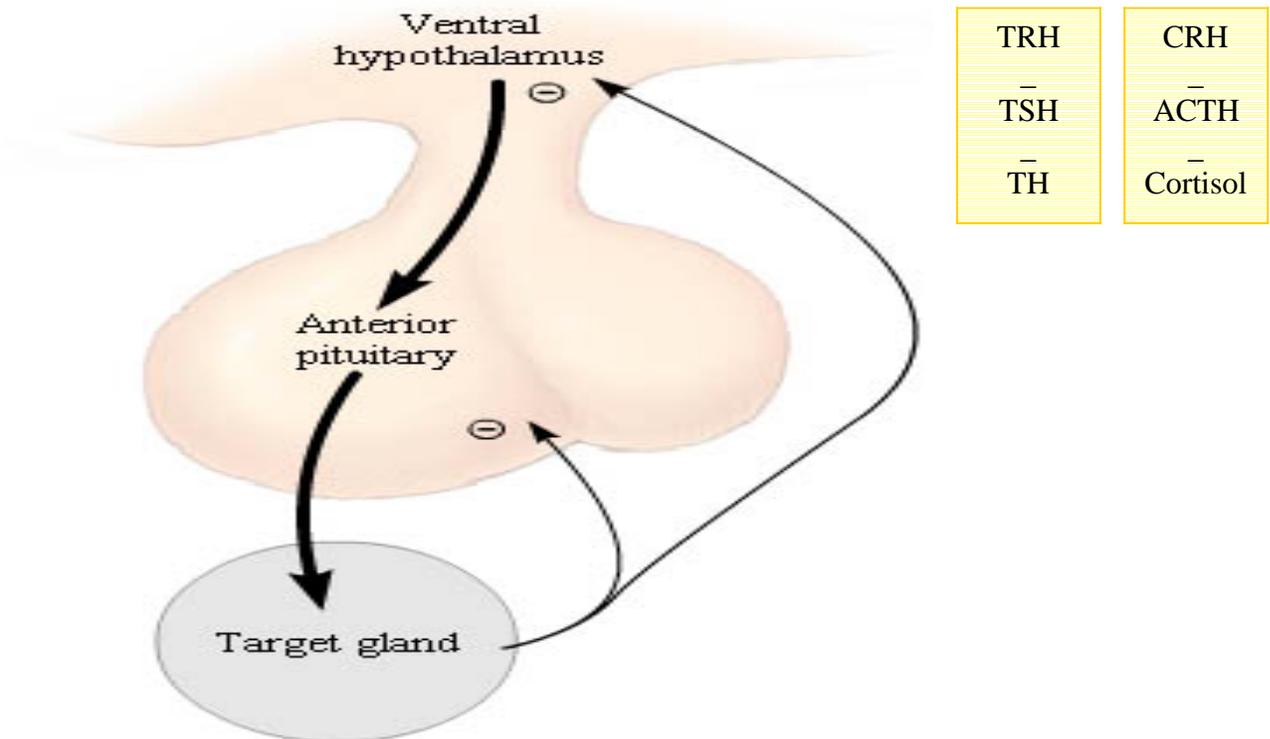
- Click the quiz button on the left side of the screen.
- Click on the scrolling page list at the top of the screen and complete questions 1&2.
- When you are finished you can click the return from link button on the left side of the screen to return to the topic.

## Page 4. Hypothalamic Hormones

- Are the first in a series of hormones that ultimately leads to the secretion of hormones by specific endocrine glands.
- Several of the hypothalamic hormones stimulate tropic hormones in the anterior pituitary.
- Observe the following diagram closely to see how hypothalamic hormones influence the regulation of secretions of other endocrine glands.



- For each hormone series, negative feedback loops control circulating levels of the target gland hormones.
- Negative feedback from the target gland can be directed at the anterior pituitary, the ventral hypothalamus or both.



- The hypothalamic hormones also maintain the anterior pituitary and the tropic hormones help to maintain their target endocrine glands.
- In some instances hormones of one series will cause the secretion of the hormones of another series (i.e. TH stimulates secretion of GH).
- Prolactin (PRL) is unique because its primary stimulus from the hypothalamus is inhibitory except after birth when milk production begins.

**\*\*Now is a good time to go to the quiz questions #3 &4.**

- Click the quiz button on the left side of the screen.
- Click on the scrolling page list at the top of the screen and complete questions 3 &4.
- When you are finished you can click the return from link button on the left side of the screen to return to the topic.

**Page 5. Hypothalamus, Autonomic Nervous System, and Neuroendocrine interactions**

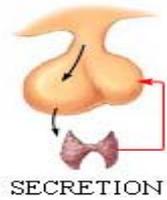
- Parts of the cerebral cortex, limbic system, basal nuclei, reticular formation, and retina all project to the thalamus.
- Strong emotions, ingestion of food, painful stimuli, trauma, infection, hot/cold extremes, and light input from the retina can influence the endocrine system through these hypothalamic circuits.
- There are several examples of how the hypothalamus mediates endocrine responses.
  1. Neuroendocrine reflexes
    - Suckling or crying can initiate the milk letdown reflex.
    - Sensory input→oxytocin→mammary glands→milk letdown.
  2. Chemically sensitive neurons.
    - Osmoreceptors in hypothalamus are stimulated by high concentrations of solute in the blood.
    - This leads to synthesis and release of ADH.
    - ADH targets the kidneys and promotes the reabsorption of water.
  3. Circadian rhythms
    - Some hormones exhibit daily fluctuations.
    - Input from the retina onto the hypothalamus is one way in which day/night hormones levels fluctuate.
    - Cortisol has pronounced high and low peaks throughout the day.

**\*\*Now is a good time to go to the quiz question #6.**

- Click the quiz button on the left side of the screen.
- Click on the scrolling page list at the top of the screen and complete question 6.
- When you are finished you can click the return from link button on the left side of the screen to return to the topic.

**Page 6. Thyroid Hormone Review**

- Be sure to view all the steps in the animations on this page and make notes in the spaces provided below.
- All of these concepts have been covered in other topics.



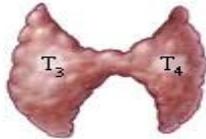
SECRETION



TRANSPORT



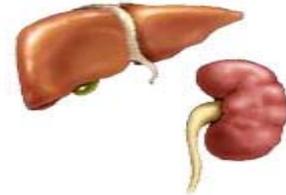
CELLULAR  
MECHANISM OF  
ACTION



SYNTHESIS



FUNCTIONS



BREAKDOWN

- Secretion
- Transport
- Cellular Mechanism of Action
- Synthesis
- Functions
- Breakdown

## Page 7. Hypothyroidism and Hyperthyroidism

- Diseases of the thyroid gland are common.
- When viewing the symptoms of hyposecretion or hypersecretion keep in mind the metabolic effects that TH has on its target tissues.
- Listed below are common symptoms of both hyposecretion and hypersecretion of TH.

## HYPOSECRETION



- Listlessness
- Low **BMR**
- Feeling of no energy
- Feeling cold
- Lethargy
- Sleepiness
- Mental sluggishness
- Impaired memory
- Slowed speech
- Slowed reflexes

## HYPERSECRETION



- High BMR
- Restlessness
- Hyperexcitable
- Sweating
- Weight loss despite ample food
- Irritability
- ↑ Heart rate
- Nervousness
- Exaggerated responses to stimuli in the environment
- Heart pounding  
(↑ force of contraction)

- Chronic hyposecretion can lead to **myxedema**.
- Chronic hypersecretion can be caused by tumors or an autoimmune disease known as **Grave's disease**.
- Diseases of the thyroid can be primary or secondary in nature
  - **Primary disease** is one in which the gland itself is affected.
  - **Secondary Disease** is when the anterior pituitary or the hypothalamus is not functioning properly.
- Primary hypothyroidism can be caused by:
  1. Failure of thyroid gland to secrete TH.
  2. Lack of dietary iodine leads to insufficient TH production.
- Secondary hypothyroidism can be caused by:
  1. A lack of TSH or TRH due to pathology.
- Primary hyperthyroidism can be caused by:
  1. Tumor of thyroid gland.
  2. Grave's disease.
- Secondary Hyperthyroidism can be caused by:
  1. Excess secretion of the anterior pituitary or hypothalamus.
- Keep in mind when reviewing this page that excesses of hypothalamic and pituitary hormones will have positive effect on thyroid gland and cause it to enlarge. A lack of

hypothalamic or pituitary hormones will have negative effect on the size of the thyroid gland.

**\*\*Now is a good time to go to the quiz question #5.**

- Click the quiz button on the left side of the screen.
- Click on the scrolling page list at the top of the screen and complete question 5.
- When you are finished you can click the return from link button on the left side of the screen to return to the topic.

**Page 8. Summary**

- Hypothalamic neurons produce hormones.
- Some hypothalamic hormones enter the systemic circulation from the posterior pituitary gland and others influence the anterior pituitary via the hypophyseal portal system.
- TSH, FSH, LH, ACTH, and GH from the anterior pituitary influence secretion of a third hormone from a target gland (tropic effects).
- Target gland hormones can exert negative feedback control of the hypothalamus and/or anterior pituitary.
- Neurons throughout the brain influence the hypothalamus.
- All about thyroid hormone, and the causes and consequences of hypo- and hypersecretion of TH.

**Notes on Quiz Questions**

**Quiz Question #1: Pituitary Anatomy and Hormones.**

- The first part of this question has you label the parts of the hypothalamus and pituitary gland.
- The second part of this question requires you to place the posterior pituitary hormones where they are produced.
- The third part of this question requires you to place the six anterior pituitary hormones on the diagram where they are produced.
- The fourth part of this question requires you to identify the two inhibiting hypothalamic hormones.
- The final part of this question requires you to place the hypothalamic hormones at their correct sites of production.

**Quiz Question #2: Hypothalamic and Pituitary Hormones**

- The first part of this question requires you select eight hormones that are secreted **directly** into the systemic circulation by either the hypothalamus or the pituitary gland.
- The second part of this question requires you to identify the hypophyseal portal veins.

**Quiz Question #3: Cortisol and Negative Feedback**

- This question requires you to use your knowledge of the negative feedback loop between CRH→ACTH→Cortisol.
- You will be given a clinical problem and you must predict the results of the clinical tests that were administered.

**Quiz Question #4: Prolactin and Inhibition**

- This question deals with the unique relationship between prolactin and dopamine.

- Remember that under normal circumstances prolactin secretion is inhibited.

**Quiz Question #5: Hypothyroidism**

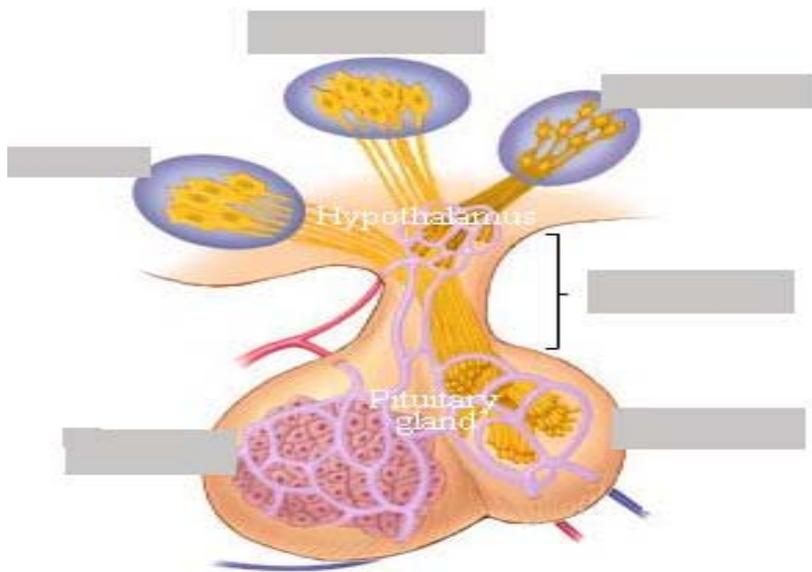
- This question presents you with a clinical problem dealing with primary hypothyroidism.
- Keep in mind that a primary disease is one in which the endocrine gland is not working properly. Use your knowledge of negative feedback to predict what will happen with treatment.

**Quiz Question #6: Circadian Rhythms**

- This question requires you to choose which events will upset the circadian rhythm.
- Remember that your circadian rhythm is set by light/dark cycles.

**Study Questions on Endocrine System Review**

1. (Page 3.) Label this figure



- Supraoptic nuclei
- Paraventricular nuclei
- Ventral nuclei
- Anterior pituitary
- Posterior pituitary

2. (Page 3.) What is the name of the specialized capillary system that connects the ventral hypothalamus to the anterior pituitary?

3. (Page 3.) Match the following hypothalamic hormones with their functions:

- TRH
- CRH
- GNRH
- DA
- ADH
- GHRH

\_\_\_\_\_ a. Inhibits production of prolactin

\_\_\_\_\_ b. Stimulates secretion of FSH and LH

\_\_\_\_\_ c. Triggers secretion of TSH

\_\_\_\_\_d. Stimulates the secretion of GH

\_\_\_\_\_e. Promotes water reabsorption by the kidneys

\_\_\_\_\_f. Causes the secretion of ACTH

4. (Page 3.) What is a tropic hormone?
5. (Page 3.) What are the major tropic hormones of the anterior pituitary and what are their targets?
6. (Page 4.) High levels of cortisol due to injections of cortisone will have what effect on the secretion of CRH and ACTH?
7. (Page 4.) Lack of TSH would lead to a \_\_\_\_\_ in TH.
8. (Page 4.) Why is secretion of PRL unique amongst hormones of the hypothalamic-pituitary axis?
9. (Page 4.) In general hormones of the hypothalamic-pituitary axis are maintained by a \_\_\_\_\_ mechanism.
10. (Page 5.) Which of the following would not influence the endocrine system via the hypothalamus?
  - a. strong emotions
  - b. bright lights
  - c. painful stimuli
  - d. infections
  - e. all of the above would influence the endocrine system via the hypothalamus
11. (Page 5.) Hormones such as cortisol exhibit daily fluctuations that are part of our bodies normal \_\_\_\_\_.
12. (Page 6.) What are the main ingredients necessary for TH synthesis?
13. (Page 6.) True or False: TH binds with plasma membrane receptors.
14. (Page 6.) List several of the main functions of TH.
15. (Page 7.) Mental sluggishness can be a symptom of \_\_\_\_\_.
16. (Page 7.) Grave's disease is usually a primary/secondary disease of the thyroid gland.
17. (Page 7.) Excessive secretions of TSH from the anterior pituitary can lead to \_\_\_\_\_.