

# Hormones: Chemical Regulators

## 10.1

### Vocabulary

protein hormone

steroid hormone

glucagon

Textbook pp. 468–472

**MAIN IDEA:** Most hormones are chemicals secreted by the cells of the endocrine system that control the activities of cells elsewhere in the body. Most hormones are either protein hormones or steroid hormones. Protein hormones are water-soluble and tend to bind to plasma membrane receptors. Steroid hormones are lipids and not as water-soluble, but they pass easily through the plasma membrane and tend to attach to receptors inside the cell.

- Use **Table 1** to compare protein hormones and steroid hormones. **K/U C**

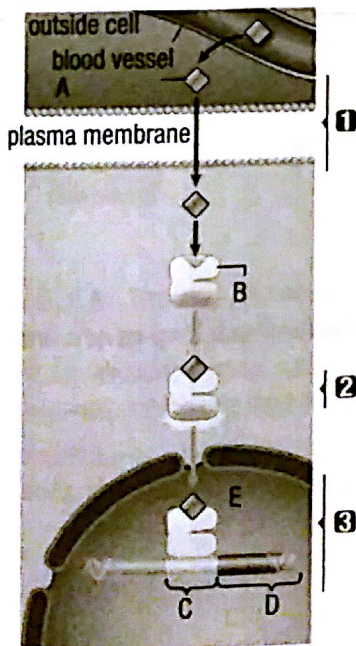
**Table 1** Protein Hormones versus Steroid Hormones

	Protein hormone	Steroid hormone
Composition		
Solubility		
Interactions at plasma membrane		
Major examples		

- How are hormones removed from the body? **K/U**

**MAIN IDEA:** Only target cells that have the correct receptor proteins respond to the presence of a specific hormone. Once a receptor protein is bound to a hormone, it signals other proteins inside the cell to turn certain cellular processes on or off.

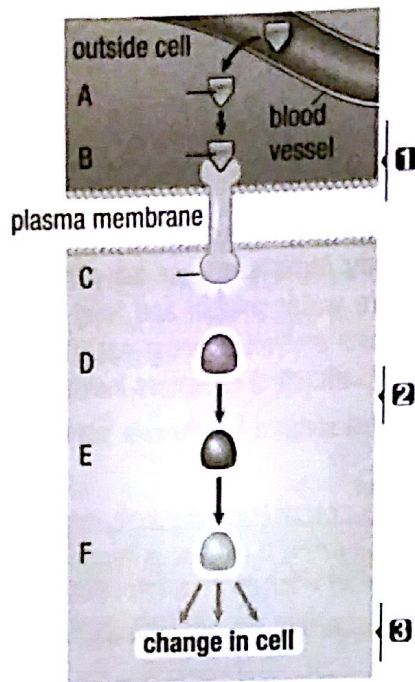
- Label **Figure 1** to show how a hormone binds to a receptor inside the cell. Describe the events that occur at sites 1, 2 and 3. **K/U C**



- A. \_\_\_\_\_
1. \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- B. \_\_\_\_\_
2. \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- C. \_\_\_\_\_
- D. \_\_\_\_\_
- E. \_\_\_\_\_
3. \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**Figure 1**

4. Label Figure 2 to show how a hormone binds to a receptor in the plasma membrane. Describe the events that occur at sites 1, 2 and 3. **K/U C**



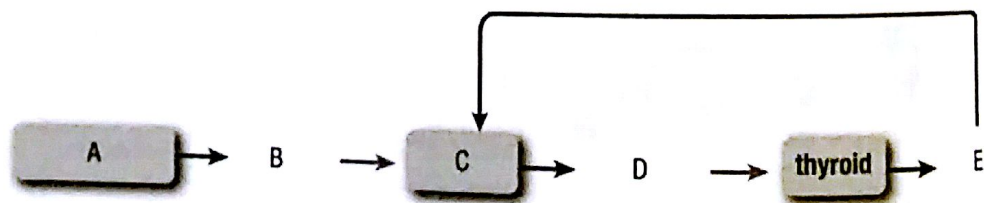
- A. \_\_\_\_\_  
 B. \_\_\_\_\_  
 1. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 C. \_\_\_\_\_  
 D. \_\_\_\_\_  
 2. \_\_\_\_\_  
 \_\_\_\_\_  
 E. \_\_\_\_\_  
 F. \_\_\_\_\_  
 E. \_\_\_\_\_  
 3. \_\_\_\_\_  
 \_\_\_\_\_

Figure 2

**MAIN IDEA:** Many hormones are controlled by negative feedback mechanisms. In a negative feedback mechanism, the increasing concentration of a chemical turns off further production of a hormone. The glands of the endocrine system and their hormones work together to control other body systems and maintain homeostasis.

5. Identify the parts of the flow chart to illustrate an example of a hormone negative feedback loop. **K/U C**

\_\_\_\_\_ hypothalamus      \_\_\_\_\_ thyroid hormones      \_\_\_\_\_ TSH  
 \_\_\_\_\_ pituitary      \_\_\_\_\_ TRH



6. Identify the sensor, integrator, and effector in the feedback loop in question 4. **K/U**

# The Endocrine Glands

## 10.2

### Vocabulary

hypothalamus  
neurohormone

pituitary gland  
thyroid gland

parathyroid hormone  
pineal gland

Textbook pp. 473–482

**MAIN IDEA:** The endocrine system of glands and the hormones they produce regulate bodily processes, maintain homeostasis, and control growth, development, and reproduction.

1. Label the major human endocrine glands shown in Figure 1. **K/U TC**

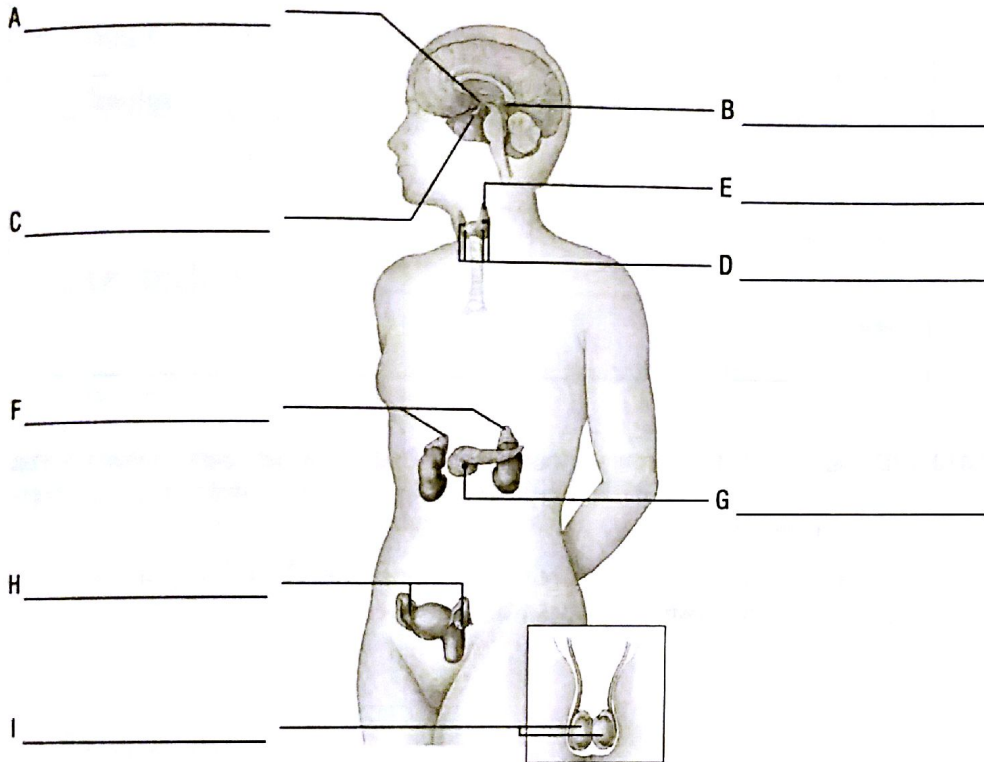


Figure 1

2. In addition to the main endocrine glands shown in Figure 1 above, what other organs in the human body produce important hormones? **K/U**

**MAIN IDEA:** The hypothalamus and pituitary gland control other endocrine glands throughout the body. The hypothalamus responds to messages from the brain or nerve receptors by releasing hormones. These hormones control the pituitary gland's secretion of other hormones, which regulate the rest of the endocrine system.

3. Describe two conditions caused by a malfunction in two different endocrine glands. Explain in detail what has gone wrong in each case. **K/U**

### STUDY TIP

#### Prefixes

Prefixes can help you remember the names of glands. For example, *hypo-* means "above," *para-* means "around," and *ad-* means "on".

4. Complete **Table 1** to describe one hormone produced by each endocrine gland and its function. **K/U C**

**Table 1** Endocrine Gland Hormones

Endocrine gland	Hormone	Function
hypothalamus		
anterior pituitary gland		
posterior pituitary gland		
thyroid gland		
parathyroid gland		
adrenal glands		
pineal gland		

**MAIN IDEA:** Many of the hormones found in vertebrates are also found in invertebrates, although their functions may differ. Hormones in invertebrates control metamorphosis, moulting, and reproduction.

5. The hormones ecdysone and juvenile hormone control moulting in insects. Explain how these two hormones work together. **K/U**

6. Crustaceans also shed their exoskeleton as they grow. Compare the roles that hormones play in crustacean moulting with the roles that hormones play in insect moulting. **K/U T/I**

# Regulating Blood Sugar

## Vocabulary

islets of Langerhans

Textbook pp. 483–487

**MAIN IDEA:** The islets of Langerhans in the pancreas secrete insulin, which lowers the blood glucose level, and glucagon, which raises the blood glucose level. The balance of insulin and glucagon regulates the concentration of glucose in the blood.

- For each function of the pancreas in Table 1 below, identify the source of the function and describe each process. **KU** **17**

**Table 1** Functions of the Pancreas

Function	Source	Process
secretion of digestive enzymes		
lower blood sugar levels		
raise blood sugar levels		

- You eat a meal with a high sugar content. Explain how each factor below will respond and why. **KU** **17**

(a) blood sugar

(b) alpha cells

(c) beta cells

- You have not eaten a meal after several hours of exercise. How will each factor below respond and why? **KU** **17**

(a) blood sugar

(b) alpha cells

(c) beta cells

## STUDY TIP

### Review Prior Learning

Insulin and glucagon are part of negative feedback mechanisms. Review negative feedback mechanisms in Chapter 9 and in Section 10.1.

4. What are some symptoms of hypoglycemia and of hyperglycemia? **KSU**

**MAIN IDEA:** Diabetes mellitus is a disease in which the blood glucose level is not properly regulated due to a failure of insulin production or action. Type 1 diabetes is caused by an inability to produce insulin, due to a failure of beta cells in the islets of Langerhans. It tends to develop during childhood. Type 2 diabetes is caused by insulin insufficiency and/or by the inability of cells to respond correctly to insulin. It tends to develop during adulthood, often as a result of obesity.

5. Draw a flow chart to illustrate how diabetes can result in excess thirst. **KSU**

6. Describe three serious effects of diabetes. **KSU**

7. Complete Table 2 to compare type 1 and type 2 diabetes. **KSU**

**Table 2** Diabetes Comparison

	Type 1 Diabetes	Type 2 Diabetes
Onset		
Possible cause(s)		
Most effective treatments		
Possibility of cure		

8. Why do you think more intensive treatment is often required to manage type 1 diabetes than type 2 diabetes? **KSU**

## Insulin: A Miracle Discovery

Textbook pp. 488–489

**MAIN IDEA:** Banting and Best's initial trials on dogs failed but led them to other conclusions that helped them to discover insulin in 1922.

1. Previous scientists had shown that if the pancreas of a dog is removed, the dog contracts diabetes. What hypotheses did Banting and Best propose to clarify this finding? **K/U**
2. (a) What did Banting and Best believe caused the dog in their first experiment to develop diabetes?  
  
(b) How did they learn that the diabetes they observed was not caused by the mechanism you described in part (a)? **K/U T/I**
3. Why do you think the dog that Banting and Best removed the pancreas from and injected insulin into eventually died? **T/I**
4. (a) Describe the difficulties that needed to be overcome before giving insulin to humans.  
  
(b) How did Banting and Best overcome the difficulties you described in part (a)? **K/U**
5. Describe how modern biotechnology has contributed to the issue of diabetes treatments. **K/U**

### STUDY TIP

#### Unsupported Hypothesis

You can learn just as much, if not more, from a hypothesis that your experimental data does not support as you can from a hypothesis that your experimental data does support.

# Steroids: Natural and Synthetic

Textbook pp. 490–493

### Vocabulary

testosterone  
estrogens

progestins  
synthetic hormone

**MAIN IDEA:** Steroids belong to a category of lipids that includes several hormones that act on receptors inside cells. Natural steroid hormones occur in the human body and control both male and female sexual development and reproduction, the adrenal fight-or-flight response, and the blood glucose level.

1. Complete the following description of the interaction between the steroid hormone receptor and the steroid hormone response element. **K/U**

The \_\_\_\_\_ is a protein in the \_\_\_\_\_ of the cell. It has a specific \_\_\_\_\_ that will be activated when the matching \_\_\_\_\_ enters the cell. The steroid hormone receptor binds to the \_\_\_\_\_ and transports it into the \_\_\_\_\_. The \_\_\_\_\_ is a DNA element adjacent to the \_\_\_\_\_ whose expression is controlled by the \_\_\_\_\_. The \_\_\_\_\_ binds to the \_\_\_\_\_, which activates transcription of the \_\_\_\_\_, resulting in the production of \_\_\_\_\_.

2. Complete **Table 1** to summarize the functions of natural steroids and their value to athletes. **K/U T/A IC IA**

### STUDY TIP

#### Suffixes

Many steroid hormones end in the suffix *-one*. This shows that they include a carbonyl group (CO) attached to the steroid skeleton. Cortisol has a hydroxyl, or alcohol, group (OH) attached to the steroid skeleton.

**Table 1** Natural Steroids

Steroid	Function	Value to athlete
testosterone		
cortisol		

**MAIN IDEA:** There are many legitimate medical uses of synthetic steroids, including as painkillers and anti-inflammatories such as those found in asthma inhalers. Steroid use should only be for a valid medical reason, and must be supervised by a physician.

3. Describe the interaction of a synthetic hormone and a steroid hormone receptor. **K/U T/A**



4. Complete **Table 2** to summarize the uses and side effects of synthetic hormones. **K/U T/I C**

**Table 2** Synthetic Steroids

Steroid	prednisone	beclomethasone	dexamethasone	hydrocortisone
Therapeutic use				
Possible side effects				

**MAIN IDEA:** There are many uses of synthetic steroids that are banned in the world of sports. The long-term use of synthetic steroids can lead to baldness, shrinking testes, irregular reproductive cycles, and many other physical and psychological side effects.

5. Use what you know about the effects of each hormone in Question 4 to predict what value it may have to an athlete's performance in competition. **K/U T/I**

6. On a separate sheet of paper, construct a Venn diagram to classify potential side effects of the long-term use of anabolic steroids as particular to males, particular to females, or common to both. **K/U T/I C**
7. Complete **Table 3** to show how athletes can improve their performance with and without using synthetic steroids. **K/U T/I C IA**


**Table 3** Improved Athletic Performance

Desired effect	With synthetic steroids	Without synthetic steroids
increased muscle mass		
increased oxygen supply		
increased reaction time		
increased endurance		
decreased pain levels		

Textbook pp. 494–495

## The Cost of Performance-Enhancing Drug Use

**MAIN IDEA:** Performance-enhancing drug use comes with a heavy physical and social cost.

1. Performance-enhancing drug use by athletes is believed to be both unfair and widespread. Decide whether you agree or disagree with each statement below and justify your opinion. 

(a) Using performance-enhancing drugs is just another example of how athletes bend or break rules in sport so it's not really an issue.

(b) The ban is unfair because it is hard to differentiate natural hormones from synthetic hormones.

(c) The ban is unfair because natural hormone levels vary so one athlete might test positive while another tests negative after using the same banned hormone.

(d) Banning athletes from using painkillers and cold medicines is unfair because people in other professions can use them when they are working.

(e) Athletes are allowed to use drugs, such as alcohol and nicotine, which have proven health risks, so banning performance-enhancing drugs on health grounds is hypocritical.

### STUDY TIP

#### Justification

Explain your reasoning process thoroughly. While your opinion is important, a clear justification of it based on evidence is even more helpful in consolidating what you have learned.

# The Reproductive Hormones



10.7

## Vocabulary

gonads	oogenesis	menstrual cycle
androgens	menopause	spermatogenesis
gonadotropin-releasing hormone (GnRH)		

Textbook pp. 496-503

**MAIN IDEA:** Reproduction is controlled by the sex hormones, which are primarily produced in the gonads: the testes in males and the ovaries in females.

1. Label the reproductive organs shown in Figure 1.  

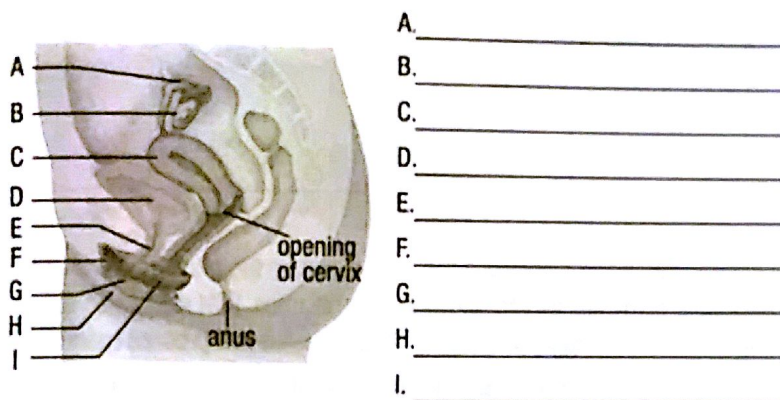




Figure 1 Female Reproductive Organs

2. Label the reproductive organs shown in Figure 2.  

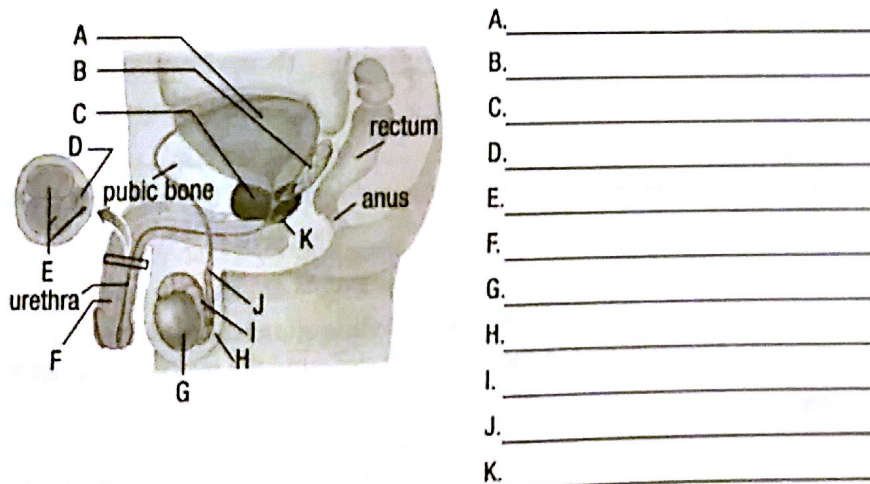




Figure 2 Male Reproductive Organs

**MAIN IDEA:** Testosterone is the primary sex hormone in males, and estrogen is the primary sex hormone in females. These hormones control the development of the secondary sexual characteristics and the sex drive.

3. What triggers the synthesis of testosterone in males? Compare this to the trigger for the synthesis of estrogen in females.  

4. Complete **Table 1** to summarize the roles played by testosterone and estrogen. **120**

**Table 1** Roles of Testosterone and Estrogen

	Testosterone	Estrogen
Source		
Target structure or cells		
Gender primarily affected		
Main functions		

**STUDY TIP**

**Full Name**

These and other hormones are often referred to by initials. Learn the full name of each hormone to help you remember what the initials stand for. This will help you make more sense of what you read.

**MAIN IDEA:** Follicle-stimulating hormone (FSH) is released by the pituitary gland in response to gonadotropin-releasing hormones (GnRH) from the hypothalamus. FSH stimulates the development of oocytes in the ovary. Ova (eggs) are produced from oocytes in a process called oogenesis.

5. Complete the paragraph to describe the process of fertilization. **121**

\_\_\_\_\_ hormone from the \_\_\_\_\_ causes \_\_\_\_\_ secretion in the \_\_\_\_\_, leading to \_\_\_\_\_, which starts \_\_\_\_\_ secretion. The egg descends into the \_\_\_\_\_ where it is fertilized by a \_\_\_\_\_. The first cell divisions of the \_\_\_\_\_ occur in the \_\_\_\_\_ then, after about seven days, the \_\_\_\_\_ is implanted in the \_\_\_\_\_. The cells secrete \_\_\_\_\_ to keep the \_\_\_\_\_ in the ovary from breaking down. Continued activity of the corpus luteum keeps \_\_\_\_\_ and \_\_\_\_\_ secretion at high levels, which maintains the \_\_\_\_\_ and prevents \_\_\_\_\_.

6. Complete **Table 2** to summarize the roles of follicle-stimulating hormone, luteinizing hormone, and progesterone in the menstrual cycle and the ovarian cycle. **121**

**Table 2** Female Hormones

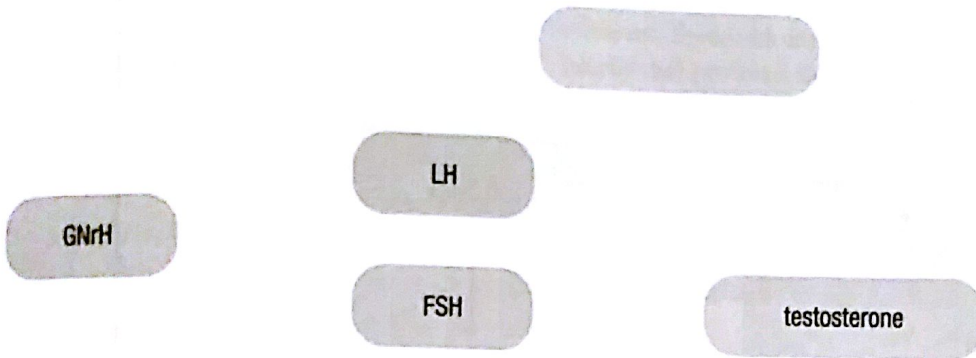
	FSH	LH	Progesterone
Source			
Target structure or cell			
Main function			

**MAIN IDEA:** Spermatogenesis, the production of sperm in the testes of the male, is controlled by the male androgen hormone testosterone. Males produce sperm constantly, at a rate of about 130 million per day.

7. Complete the summary of spermatogenesis. **K/U**

Spermatogenesis takes place in the \_\_\_\_\_ tubules in the \_\_\_\_\_. The developing spermatocytes are surrounded by \_\_\_\_\_ cells, which supply \_\_\_\_\_ and seal off the spermatocytes from the body's \_\_\_\_\_ supply. \_\_\_\_\_ cells produce testosterone and other androgens. Mature sperm move into the \_\_\_\_\_ and from there into the \_\_\_\_\_, a thick-walled, muscular tube.

8. Complete the flow chart to illustrate two negative feedback mechanisms involved in the synthesis of testosterone. **K/U T/I IC**



**MAIN IDEA:** The hormones estrogen and progesterone carefully control the menstrual cycle to go along with the ovarian cycle and prepare the body for pregnancy. The manipulation of hormones in females can be used to control reproduction.

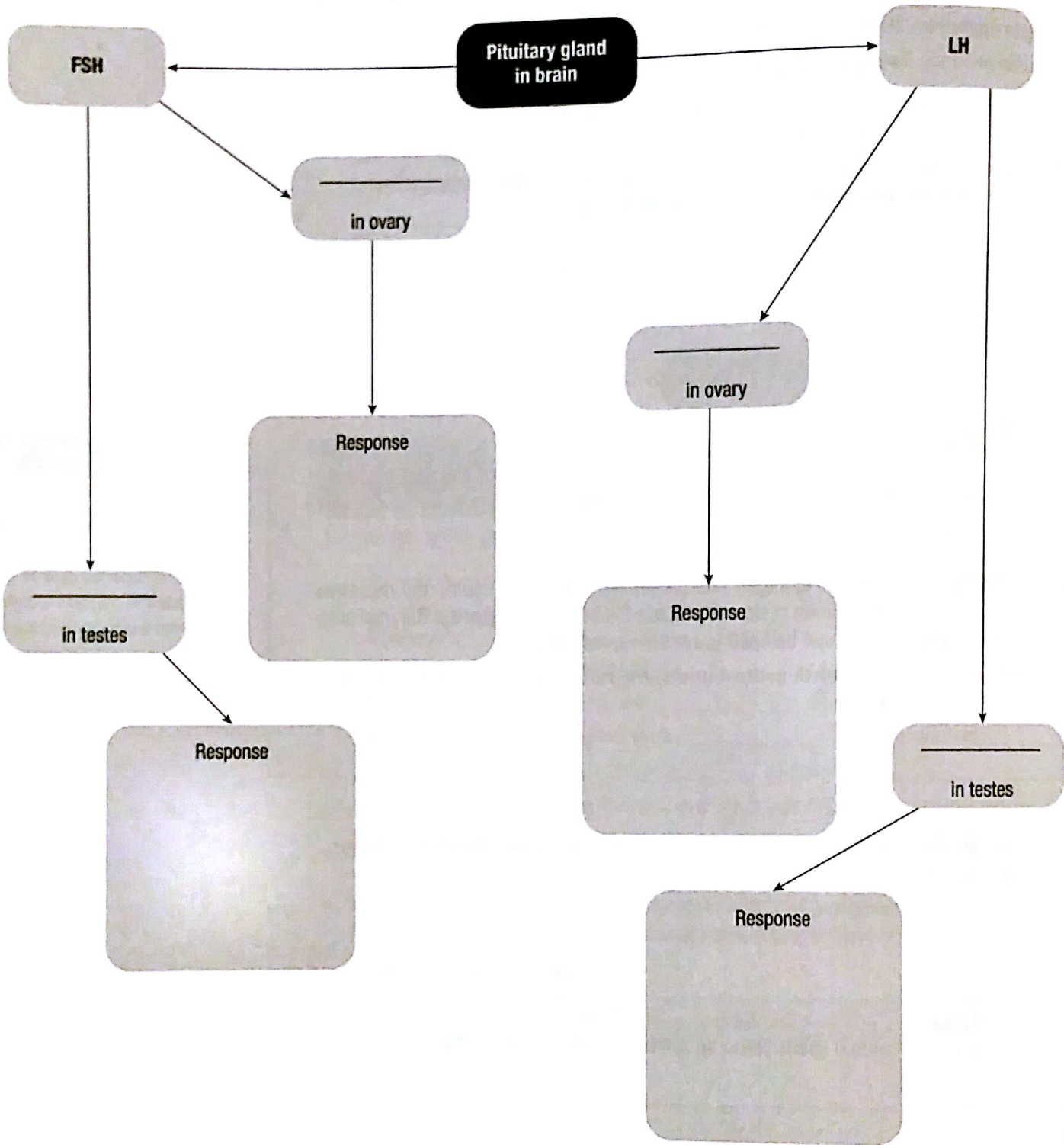
9. How does hormonal birth control mimic the function of female reproductive hormones? **K/U T/I SA**





10. Describe six side effects of hormonal birth control. Classify them as common, uncommon, or rare. **K/U**







11. Why is any hormonal medication an environmental issue? **K/U T/I**

**The Endocrine System**

The reproductive hormones in males and females demonstrates the concept of control by negative feedback. Complete the following flow chart.





-  Knowledge/Understanding
-  Thinking/Investigation
-  Communication
-  Application

1. Which factor is controlled by ADH? (10.2) 
  - (a) the level of glucose in the blood
  - (b) the amount of water re-absorbed in the nephron
  - (c) the development of the lining of the uterus
  - (d) the release of an ovum from the ovary
  
2. Anti-diuretic hormone is secreted by which organ? (10.2) 
  - (a) thyroid
  - (b) adrenal glands
  - (c) pituitary gland
  - (d) hypothalamus
  
3. Indicate whether each statement is true or false. If you think a statement is false, rewrite it to make it true. 
  - (a) After other scientists showed that dogs without a pancreas developed diabetes, Frederick Banting and Charles Best isolated a factor they called isletin that reversed the dogs' symptoms. (10.4)
  
  - (b) Large amounts of hormone are required to cause change. (10.1)
  
  - (c) Insulin is produced in a healthy person when blood sugar is low. (10.3)
  
  - (d) People with diabetes feel tired because of low levels of glucose in the blood. (10.3)
  
  - (e) Both males and females synthesize GnRH, FSH, and LH. (10.7)
  
4. What condition is caused by insufficient production of ADH? (10.2) 
  
5. Three patients are under observation for a period of 10 days. **Table 1** shows the medical assessment for each patient. (10.2)  

**Table 1** Patient Test Results

	Mr. Janvier	Mr. Yamamoto	Ms. Desai
Urine produced/day	1.5 L	13 L	0.2 L
Sweat	normal	above normal	none
Thirst	normal	intense	none

- (a) Which patient has hyposecretion of the pituitary gland?
  - (b) Which patient has hypersecretion of the pituitary gland?
6. Mrs. Schwartz has lost a lot of weight, has a low blood calcium level and protruding eyes, is easily agitated, and always feels cold. What condition could cause these symptoms? (10.2)  

7. Metabolic homeostasis concerns the thyroid gland. The thyroid is regulated by feedback loops involving which of the following? (10.1) **K/U**
- the pituitary gland and two hormones
  - the hypothalamus, pancreas and four hormones
  - the hypothalamus, the pituitary gland and three hormones
  - the islets of Langerhans and three hormones
8. Complete the sentences below to explain how hormones work. (10.1) **K/U**
- Hormones attach to specific cells by their \_\_\_\_\_.
- \_\_\_\_\_ hormones attach to receptors within the cytoplasm.
- \_\_\_\_\_ hormones attach to receptors on the cell membrane.
9. During an allergic response to a bee sting or pollen, which hormone is often released? (10.2) **K/U**
10. What is an indicator that a person's thyroid gland has malfunctioned and failed to secrete sufficient thyroxine? (10.2) **K/U**
11. How does adrenaline affect the flow of blood? (10.2) **K/U**
12. Give an example of a hormone that regulates a positive feedback mechanism. (10.2) **K/U**
13. Long term stress is harmful and often results in higher blood sugar levels. List three complications that may result from having a high blood sugar level. (10.3) **K/U**
14. List three side effects of taking anabolic steroids. (10.6) **K/U**
15. Where is the primary production site of progesterone? (10.7) **K/U**
16. Provide an example of a hormone that is non-target in behaviour and explain why this is necessary. (10.3) **K/U**
17. People who have severe allergies to bee stings or peanuts usually carry a syringe with a solution of adrenaline. How does this help them recover from an allergic reaction? (10.2) **K/U T/I A**
18. Why are some performance-enhancing drugs difficult to detect in athletes? Provide two examples. (10.6) **K/U**