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The Endocrine System

Brown-Sequard: The Father of Endocrinology?

Charles-Edouard Brown-Sequard (1817–1894) has been called the “Father of Endocrinology.” He was the son of an American sea captain and a French woman, and he traveled and lectured widely. Brown-Sequard noted that organs like the thyroid, liver, spleen, and kidneys secrete substances that travel into the blood. These substances were ultimately called hormones.

“Who dodges life’s stress and its strains.”

Donald Robert Perry, 1878–1937

*“Complaints is many and various,
And my feet are cold.”*

Robert Graves, 1895–1985

1. Define important words in this chapter

diabetes: a condition in which the pancreas does not produce insulin or does not produce enough insulin; causes problems with circulation and can damage vital organs.

glands: organs that produce and secrete chemicals called hormones.

hormones: chemical substances produced by the body that control numerous body functions.

hyperglycemia: high blood glucose (blood sugar).

hyperthyroidism: a condition in which the thyroid gland produces too much thyroid hormone, which causes body processes to speed up and metabolism to increase.

hypoglycemia: low blood glucose (blood sugar); also known as *insulin reaction* or *insulin shock*.

hypothyroidism: a condition in which the body lacks thyroid hormone, which causes body processes to slow down.

prediabetes: a condition in which a person’s blood glucose levels are above normal but not high enough for a diagnosis of type 2 diabetes.

thyroid: a butterfly-shaped gland in the neck that is responsible for regulating metabolism and growth.

2. Explain the structure and function of the endocrine system

The endocrine system regulates many important body functions. The endocrine system is made up of glands in different areas of the body (Fig. 23-1). The **glands** are organs that produce and secrete chemicals called hormones. **Hormones** are chemical substances created by the body that control numerous body functions. They are vital to survival. Hormones are carried in the blood for delivery to target tissues or organs.

The pituitary gland, also referred to as the *master gland*, is located at the base of the brain and

is attached to the hypothalamus. It is called the master gland due to its ability to control the hormone production of other glands. There are two parts, or lobes, of the pituitary gland: the anterior (front) and the posterior (back). The anterior lobe releases the hormones, while the posterior lobe stores hormones for release when needed.

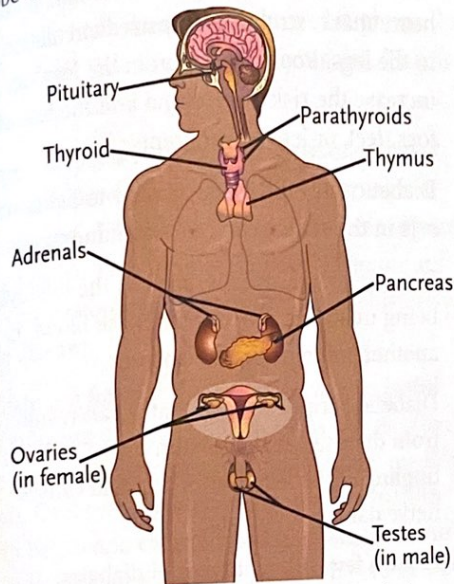


Fig. 23-1. The endocrine system includes glands that produce hormones that regulate body processes.

The **thyroid** gland is located in the neck below the larynx, or voice box. Thyroid hormones primarily regulate metabolism and growth. Metabolism is the process of breaking down and transforming all nutrients that enter the body to provide energy, growth, and maintenance. Thyroid hormones also stimulate the growth of nervous tissue.

Four tiny parathyroid glands are embedded in the thyroid gland. They are responsible for the production of parathyroid hormone. This hormone regulates the levels of vitamin D, calcium, and phosphate in the bloodstream.

Two adrenal glands are located on top of the kidneys. They secrete adrenaline (epinephrine) and noradrenaline (norepinephrine), aldosterone, and cortisol. During stressful situations, adrenaline, and the less potent noradrenaline, increase

the efficiency of muscle contractions, increase heart rate and blood pressure, and also increase blood glucose levels to provide extra energy. This is called the *fight-or-flight response*. It enhances body performance during stressful or threatening situations. Aldosterone regulates the balance of sodium, potassium, and water. Cortisol (hydrocortisone) maintains metabolism by regulating the amount of glucose (natural sugar) in the blood.

The pancreas is a gland located in the back of the abdomen and behind the stomach. The pancreas produces the hormone insulin. Insulin regulates the amount of glucose available to the cells for metabolism. Cells cannot absorb sugar without insulin.

Male and female sex glands, called the *gonads*, are endocrine glands. The ovaries in the female secrete estrogen and progesterone. The testes in the male secrete testosterone.

The functions of the endocrine system are to

- Maintain homeostasis through hormone secretion
- Influence growth and development
- Regulate levels of vitamin D, calcium, and phosphate in the body
- Maintain blood sugar levels
- Regulate the body's ability to reproduce
- Determine how quickly cells burn food for energy

Destination: Homeostasis

The parathyroid glands work to maintain calcium levels in the body. If the blood calcium gets too low—for example, due to surgery or cancer—the parathyroid glands increase production of parathyroid hormone (PTH). PTH controls vitamin D, calcium, and phosphate levels in the blood. When the blood calcium reaches the proper level, the parathyroid glands stop the production of PTH. This quick response by the parathyroid glands helps the body return to homeostasis.

Tip**Iodine Allergy and Dye**

Iodine is very important for the thyroid gland to function normally. Most people get their daily intake of iodine from common table salt. If a person is allergic to iodine, his doctor must be informed. This allergy needs to be listed in a person's medical record. Any test that requires an injection of dye into the body can cause a life-threatening allergic reaction for a person who is allergic to iodine.

3. Discuss changes in the endocrine system due to aging

Normal age-related changes for the endocrine system include the following:

- Levels of estrogen and progesterone decrease, which signals the onset of menopause in women.
- Testosterone levels in males usually decrease, but production does not stop.
- Insulin production decreases.
- The body is less able to handle stress.

4. Discuss common disorders of the endocrine system

Diabetes

Diabetes mellitus, commonly called *diabetes*, is a disease that can affect people of any age. **Diabetes** is a condition in which the pancreas does not produce insulin or does not produce enough insulin. Without insulin to process glucose, or natural sugar, glucose builds up in the blood. This causes **hyperglycemia**, or high blood sugar. Because the body is unable to get energy from the sugar in the blood, it has to find energy another way. Usually the energy is obtained by burning fat. Diabetes is common in people with a family history of the illness, in the elderly, and in people who are obese.

Diabetes can cause many complications, including the following:

- **Hypoglycemia** (insulin reaction) and diabetic ketoacidosis are complications of diabetes that can be life-threatening (Chapter 8).
- Decreased blood flow can cause problems with circulation, such as coronary artery disease or peripheral vascular disease (Chapter 19). These problems increase the risk of heart attack, stroke, or impaired circulation in the legs. Poor circulation in the legs can increase the risk of infection and the loss of toes, feet, or legs to gangrene.
- Diabetic retinopathy, or damage to blood vessels in the retina, can cause blindness.
- Damage to vital organs, such as the kidneys being unable to properly filter the blood, is another complication of diabetes.
- Diabetic peripheral neuropathy can result from diabetes. It causes numbness, pain, or tingling of the legs and/or feet and causes nerve damage over time.

There are a few different types of diabetes:

Prediabetes is a condition in which glucose levels are elevated, but not high enough to establish a diagnosis of diabetes. The CDC estimates 84 million people in the US have prediabetes, and approximately 90% are unaware they have it. Some damage to vital organs may have occurred already with prediabetes.

In order to be diagnosed with prediabetes, a fasting blood sugar level must be between 100 mg/dL (milligrams per deciliter) to 125 mg/dL. Prediabetes can be delayed or prevented with certain lifestyle changes. A change in the diet, along with daily exercise, can reduce weight and lower the risk of prediabetes or diabetes.

Type 1 diabetes is a condition that is usually diagnosed in children and young adults. It was formerly known as *juvenile diabetes*. In type 1 diabetes, the pancreas does not produce any insulin. This condition will continue throughout a person's life. Daily injections of insulin are needed, but these injections do not always

prevent complications of diabetes. Special diets help treat this disorder and must be followed carefully. Blood glucose testing must also be done to monitor diabetes.

Type 2 diabetes is the most common form of diabetes; it can occur at any age. It was formerly known as *adult-onset diabetes*. In type 2 diabetes, either the body does not produce enough insulin or the body fails to properly use insulin. This is known as *insulin resistance*.

Type 2 diabetes is the milder form of diabetes. It usually develops after age 35. However, the number of children with type 2 diabetes is growing rapidly. This form of diabetes often occurs in obese people or those with a family history of the disease.

Treatment for type 2 diabetes includes careful monitoring of blood glucose levels. It can often be controlled with diet, weight loss, and medication. Oral medications or injections of insulin will be used to control blood glucose. Smoking will be discouraged. Exercise may be ordered by a doctor to help with weight loss.

People with diabetes may have many different signs and symptoms, including the following:

- Excessive thirst
- Excessive hunger
- Excessive urination
- High blood sugar levels
- Glucose in the urine
- Very dry skin
- Fatigue
- Blurred vision or visual changes
- Slow-healing sores, cuts, or bruises
- Tingling or numbness in hands or feet
- Unexplained weight loss
- Increased number of infections

Hypothyroidism (Underactive Thyroid Gland)

Hypothyroidism is a condition in which the body lacks thyroid hormone, which causes body processes to slow down. It is an autoimmune disorder in which the body produces antibodies that attack the thyroid, interfering with the production of thyroid hormone.

Hypothyroidism is often caused by Hashimoto's thyroiditis (formerly known as *Hashimoto's disease*). Other causes include surgical removal of the thyroid gland, radioactive iodine therapy, and thyroiditis (inflammation of the thyroid). Symptoms of hypothyroidism include the following:

- Fatigue and weakness
- Weight gain
- Constipation
- Intolerance to cold
- Dry skin
- Thinning hair or hair loss
- Brittle hair or fingernails
- Slow heart rate
- Low blood pressure
- Abnormally low body temperature
- Enlarged thyroid (goiter)
- Hoarseness
- Heavier than normal menstrual periods or absent menstrual periods
- Depression

Blood tests, neck examinations, and ultrasounds of the thyroid diagnose this condition. Treatment is thyroid hormone replacement therapy.

Hyperthyroidism (Overactive Thyroid Gland)

Hyperthyroidism is a condition in which the thyroid gland produces too much thyroid hormone. Body processes speed up, and metabolism increases, causing weight loss, a rapid heartbeat,

and sweating. Nervousness and irritability may result.

Hyperthyroidism is primarily caused by Graves' disease, an autoimmune disorder in which antibodies cause the thyroid gland to produce excessive thyroid hormone. Nodules (lumps in the gland), thyroiditis, or taking too much thyroid medication can also cause hyperthyroidism. Symptoms of hyperthyroidism include the following:

- Nervousness
- Trembling, especially of the hands
- Restlessness
- Fatigue
- Visual problems or eye irritation
- Bulging or protruding eyes (exophthalmos)
- Intolerance to heat
- Excessive perspiration
- Rapid heartbeat
- High blood pressure
- Increased appetite
- Weight loss
- Changes in bowel movements
- Irregular or absent menstrual periods
- Enlarged thyroid (goiter)

Blood tests and physical examinations help diagnose this condition. Treatment includes anti-thyroid drugs, other medications called beta blockers, or radioactive iodine to destroy the thyroid gland. If a goiter is large, surgery may be done. If the thyroid is removed, the person will need to take medication for the rest of her life.

Here are a few additional resources for information relating to endocrine system disorders:

- American Diabetes Association, diabetes.org
- American Thyroid Association, thyroid.org

Obesity and Disorders of the Endocrine System

Obesity increases the risk for certain endocrine system diseases or disorders, including the following:

- Type 2 diabetes
- Insulin resistance

5. Describe care guidelines for diabetes

Care of the person with diabetes includes a plan of care associated with every system in the body. Diabetes must be carefully controlled to prevent complications and serious illness. The care plan must be followed closely.

Guidelines: Diabetes

- G** Give frequent skin care. Keep the skin clean and dry.
- G** Observe the skin carefully for sores, blisters, cuts, or any other breaks in the skin. Report any of these signs immediately to the nurse (Fig. 23-2). Wounds, skin breaks, and pressure injuries must be prevented. A small sore can grow into a large wound that may not heal, which can require amputation.



Fig. 23-2. Observe the legs and feet carefully when giving care. Poor circulation can increase the risk of infection and the loss of toes, feet, or legs to gangrene.

- G** Encourage residents to follow their exercise plans (Fig. 23-3). Exercise will be ordered

to help with circulation and maintaining a healthy weight. Walking, range of motion exercises, frequent position changes, or other activity may be ordered. Report muscle weakness, change in gait, and any change in the ability to ambulate.



Fig. 23-3. Exercise programs are very important for residents with diabetes. They help to increase circulation and maintain a healthy weight.

- G** Report complaints of pain, numbness, or tingling in the arms or legs immediately.
- G** Perform foot care carefully and as directed. Report any changes in the feet. Do not clip or trim the resident's toenails. A doctor will do this.
- G** Encourage residents to wear supportive, comfortable shoes. Shoes should fit well and not hurt the feet. Shoes made of material that breathes, such as leather, cotton, or canvas, help prevent moisture buildup. Socks made of natural fibers such as cotton or wool are best because they absorb sweat. Residents with diabetes should not go barefoot or wear tight clothing on the legs and feet.
- G** Carefully following dietary instructions is very important to help manage diabetes. Meals must be served at the same time every day. Meals and snacks, including protein shakes and other supplements, must be completely consumed in order to keep blood sugar stable. Document intake accurately. Always report to the nurse if meals and snacks are not being eaten. Report if visitors bring snacks or treats to residents.
- G** The American Diabetes Association (ADA) recommends that people with diabetes work with a registered dietitian nutritionist (RDN) or a certified diabetes educator (CDE) to help develop individualized meal plans. The ADA's website, diabetes.org, contains many ideas for planning meals.
- G** Keep track of any special tests the resident may have. Tests can affect diet and insulin dosage. If a resident is fasting for a blood test, for example, food and insulin may need to be withheld until after the test is completed. Notify the nurse immediately when the test has been completed.
- G** Perform blood glucose tests only as directed and if trained. Not all states allow NAs to perform this testing. Follow facility policy.
- G** Insulin dosage is based upon a variety of factors. Balancing factors like caloric intake, metabolism, exercise levels, stress levels, and the relative condition of the resident is important. Report if the resident is not following the care plan exactly.
- G** If any of the following occurs, notify the nurse:
 - Any sign of skin breakdown anywhere on the body, especially on the feet and toes
 - Visual changes, especially blurred vision
 - Changes in appetite or increased thirst
 - Fruity or sweet-smelling breath
 - Weight change
 - Nausea or vomiting
 - Change in urine output, any signs of urinary tract infection, fruity or sweet-smelling urine

- Changes in mobility
- Numbness or tingling in the arms or legs
- Nervousness or anxiety
- Dizziness or loss of coordination
- Irritability or confusion

Blood Glucose Monitoring

Depending on state requirements, NAs may assist the nurse with blood glucose monitoring or may receive special training on how to do this themselves. The blood glucose meter measures the level of glucose in a person's blood at any given time. Normal fasting blood glucose for a person who does not have diabetes is from 70 to 100 mg/dL (milligrams per deciliter). Fasting blood glucose for a person who has diabetes is 126 mg/dL or higher. Strips are used, along with a blood glucose meter, a special glucose monitoring machine (Fig. 23-4). The strips must not have expired. The NA should always wear gloves when assisting with this procedure. Sharps must be handled and discarded properly (Chapter 6).

The A1C (also known as *HbA1c* or *glycated hemoglobin*) and estimated average glucose (eAG) tests are used to help track and regulate glucose levels. The A1C level provides information on blood glucose over two to three months and may be tested twice a year or more. Normal A1C is considered below 5.7%. A1C ranges between 5.7 and 6.4% when a person has prediabetes and is 6.5% or higher when diabetes is present. The eAG number is calculated using the A1C result. However, the eAG is shown in milligrams per deciliter (mg/dL).



Fig. 23-4. A blood glucose meter is one type of equipment used to measure glucose levels in the blood.

6. Discuss foot care guidelines for diabetes

Quality foot care is vital for people with diabetes. Diabetes weakens the immune system, which reduces resistance to infections. Poor circulation due to the narrowing of the blood vessels also increases the risk of infection. Infections of the feet, when noted in the early stages, can be treated successfully. However, when foot infections are not caught early, they can take months to heal. If wounds do not heal, amputation of a toe, an entire foot, or a leg may be necessary.

Foot care to prevent infection should be a part of daily care of residents and is required by CMS. Keeping the feet clean and dry is a way to help prevent complications. It is important that NAs observe the feet carefully during care.

Guidelines: Safe Diabetic Foot Care

- G** Inspect and clean resident's feet every day during bathing. Make sure to check the entire foot and between the toes. See the list at the end of these guidelines for items to observe and report to the nurse.
- G** Avoid harsh soaps and hot water when bathing feet. Use only warm water and mild soaps.
- G** Always dry feet thoroughly, especially between toes. Do not rub the skin; pat it dry.
- G** Never cut toenails, corns, or calluses for any reason.
- G** Do not use any object, such as a nail stick, to try to remove dirt from a toenail.
- G** Use a doctor-recommended cream or lotion on the feet, but do not apply anything between the toes. Do not use powders. Make sure the feet are completely dry after applying lotion or cream.
- G** Check shoes for rocks or other objects before putting them on residents.

- G** Remind residents not to walk around bare-foot. Always use clean cotton socks with comfortable shoes or nonskid slippers. Do not turn socks down at the top, as this can decrease circulation. Make sure shoes fit properly.
- G** If any of the following occurs, notify the nurse:
 - Painful, tender, soft, or fragile areas, or burning in the feet
 - Rashes or bruises
 - Change in color of the skin or nails, especially reddening or blackening
 - Change in the temperature of the skin
 - Excessive dryness of the skin of the feet
 - Breaks or tears in the skin
 - Drainage or bleeding on the feet or toes
 - Corns, blisters, calluses, or warts
 - Ingrown toenails

Providing foot care for a resident with diabetes



Equipment: basin, disposable absorbent pad, mild soap, lotion, gloves, 2 washcloths, 2 towels, water thermometer, clean socks, shoes or slippers

1. Identify yourself by name. Identify the resident. Greet the resident by name.
2. Wash your hands.
3. Explain procedure to the resident. Speak clearly, slowly, and directly. Maintain face-to-face contact whenever possible.
4. Provide for the resident's privacy with a curtain, screen, or door.
5. If the resident is in bed, adjust the bed to its lowest position. Lock bed wheels.
6. Fill the basin halfway with warm water. Test the water temperature with a thermometer or against the inside of your wrist. Water temperature should be no higher than 105°F. Have the resident check water temperature to see if it is comfortable. Adjust if necessary.
7. Place the basin on a disposable absorbent pad (protective barrier) on the floor, at a comfortable position for the resident. If the resident cannot sit up on the side of the bed to do this, place the basin on the pad at the foot of the bed. Support the foot and ankle throughout the procedure.
8. Put on gloves.
9. Remove the resident's socks. Completely submerge the resident's feet in water. Soak the feet for 15 to 20 minutes.
10. Put soap on a wet washcloth. Remove one foot from the water. Wash the entire foot gently, including between the toes and around nail beds (Fig. 23-5).
11. Rinse the entire foot, including between the toes.
12. With a clean, dry towel or washcloth, pat the foot dry gently, including between the toes.
13. Repeat steps 10 through 12 for the other foot.
14. Put lotion in one hand. Warm the lotion by rubbing your hands together.
15. Starting at the toes and working up to the ankles, gently rub lotion into the feet with circular strokes. Do not put lotion between



Fig. 23-5. While supporting the foot and ankle, wash the entire foot with a soapy washcloth.

the toes. Remove excess lotion (if any) with a towel or washcloth. Make sure lotion has been absorbed and the feet are completely dry.

16. Observe the feet, ankles, and legs carefully, checking for things like dry skin, skin tears, red areas, corns, blisters, calluses, warts, rashes, or bruises.
17. Help the resident put on clean socks and shoes or slippers.
18. Empty, rinse, and dry basin. Place basin in the designated dirty supply area or return to storage, depending on facility policy.
19. Place soiled linen in the proper container.
20. Remove and discard gloves properly. Wash your hands.
21. Make the resident comfortable.
22. Remove privacy measures.
23. Leave call light within the resident's reach.
24. Wash your hands.
25. Be courteous and respectful at all times.
26. Report any changes in the resident to the nurse. Document procedure using facility guidelines.

Chapter Review

1. List four functions of the endocrine system (LO 2).
2. List three normal age-related changes of the endocrine system (LO 3).
3. What are three conditions that make it more likely for a person to develop diabetes (LO 4)?

Multiple Choice

4. Which form of diabetes is the most common (LO 4)?
 - (A) Prediabetes
 - (B) Type 1 diabetes
 - (C) Type 2 diabetes
 - (D) Diabetes mellitus
5. What is a common symptom of hypothyroidism (LO 4)?
 - (A) Rapid heartbeat
 - (B) Weight gain
 - (C) High blood pressure
 - (D) Bulging eyes
6. Which of the following is an appropriate guideline for a resident who has diabetes (LO 5)?
 - (A) The resident will need to eat meals at the same time every day.
 - (B) The resident will need to avoid exercising.
 - (C) The NA will need to trim and clean the resident's toenails.
 - (D) The resident should go barefoot to avoid having material against his feet.
7. Which of the following should an NA do when giving foot care to a resident with diabetes (LO 6)?
 - (A) The NA should use hot water to kill bacteria on the feet.
 - (B) The NA should massage lotion in between the resident's toes to keep the area soft.
 - (C) The NA should use clippers to remove corns or calluses.
 - (D) The NA should pat the feet completely dry after washing them.