

## TOPICS – Cont'd

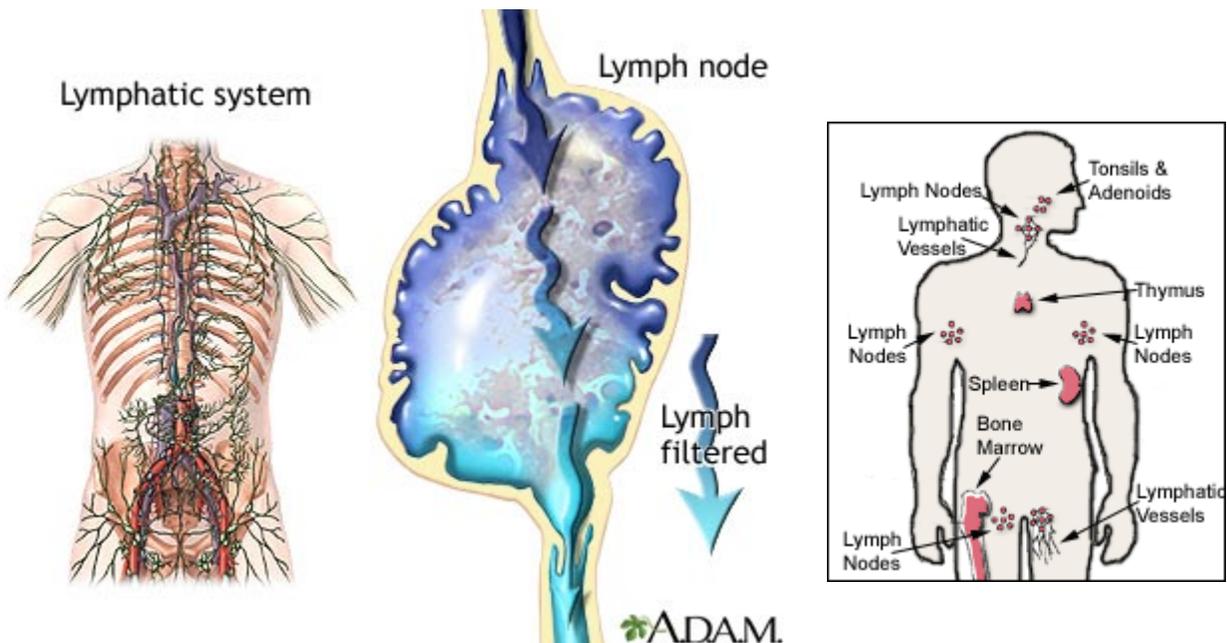
- Lymph System (+ immune system)
- Renal System
- Endocrine System

## Lymph System

The lymphatic system filters fluid from around cells. The lymph system is a network of organs, lymph nodes, lymph ducts, and lymph vessels that produce and transport lymph from tissues to the bloodstream. The functions of this system include the absorption of excess fluid and its return to the blood stream, absorption of fat (in the villi of the small intestine) and the immune system function.

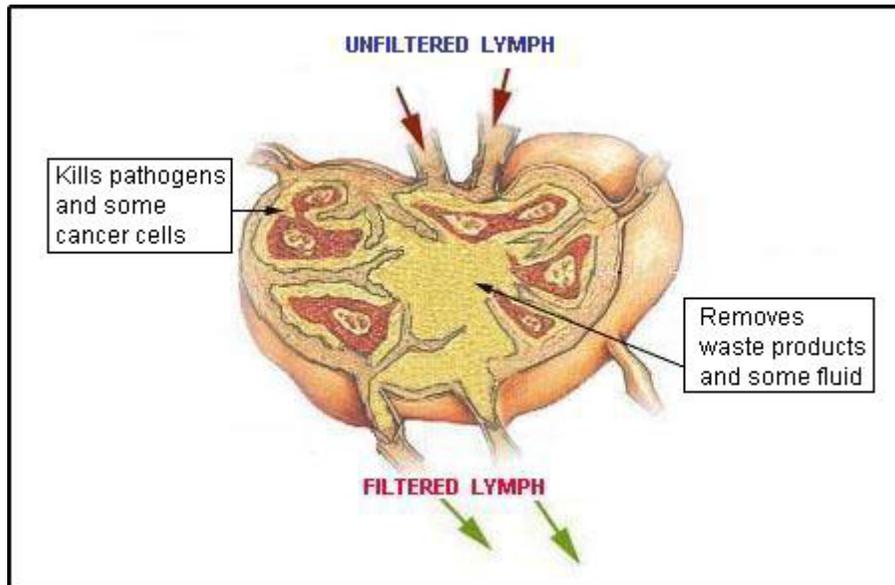
Lymph originates as blood plasma and chyle (fluid from the intestines after digestion that contains proteins and fats). The plasma of arterial blood is rich in “groceries” for the cells. In the capillary beds throughout the body the flow of blood is slowed so that plasma can leave and become tissue fluid. Tissue fluid is also known as intercellular fluid or interstitial fluid.

- Tissue fluid contains some red blood cells and many white blood cells, especially lymphocytes (lymphocytes are the cells that attack bacteria in the blood)
- Tissue fluid delivers the nutrients, oxygen, and hormones required by the cells.
- Tissue fluid collects and carries away some cellular waste products.
- 90 percent of the tissue fluid returns to the capillary bed where it again becomes plasma and continues its journey throughout the body as part of the venous circulation.
- Lymph is the 10 percent of the tissue fluid that is left behind. Normally the amount of lymph circulating in the body is one to two quarts and it makes up one to three percent of the body weight.

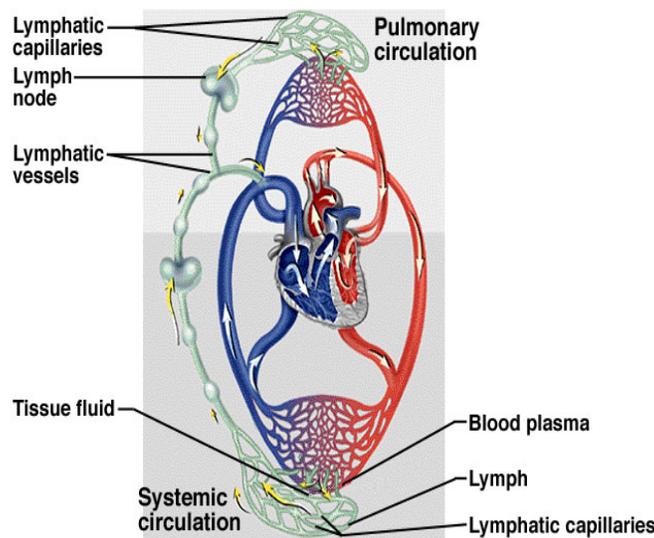


<http://www.nlm.nih.gov/medlineplus/ency/article/002247.htm>  
<http://www.stayinginshape.com/3osfcorp/libv/i67.shtml>

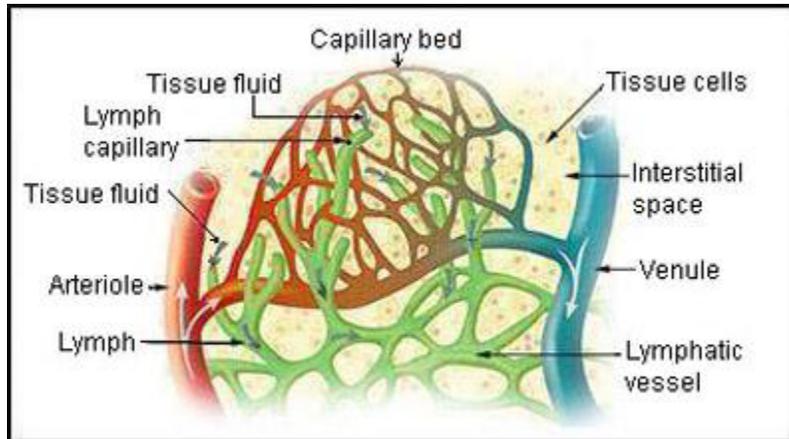
Lymph nodes are small, bean-shaped, soft nodules. They are not usually visible or easily felt. They are located in clusters in various parts of the body, such as the neck, armpit, and groin. Lymphatic capillaries, more porous than blood capillaries, drain into nodes. Nodes drain into lymph ducts, similar to veins, which ultimately drain into the subclavian veins. Contraction of skeletal muscle causes movement of the lymph fluid through valves.



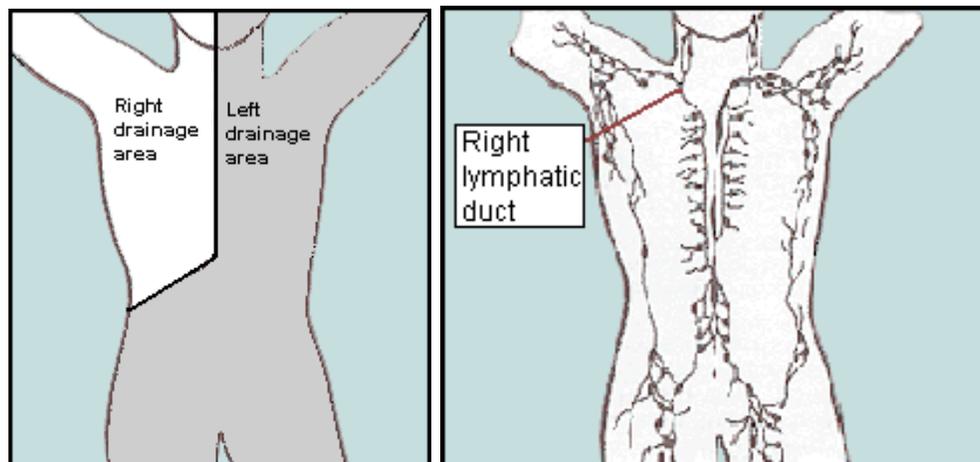
<http://www.lymphnotes.com/article.php/id/151/>



<http://www.healingdaily.com/exercise/effects-of-rebounding-on-the-lymphatic-system.htm>



<http://www.lymphnotes.com/article.php/id/151/>



<http://www.lymphnotes.com/article.php/id/151/>

Lymph nodes produce immune cells (such as lymphocytes, monocytes, and plasma cells). They also filter the lymph fluid and remove foreign material, such as bacteria and cancer cells. When bacteria are recognized in the lymph fluid, the lymph nodes enlarge as they produce additional white blood cells to help fight infection. They can become swollen from inflammatory conditions, an abscess, cancer, and most commonly from infection. Common areas where lymph nodes can be felt include the groin, armpit, behind the ears, back of the head, sides of the neck and under the jaw and chin.

The organs within the lymphatic system are the bone marrow, tonsils, adenoids, spleen, and thymus. The spleen is similar to the lymph node except that it is larger and filled with blood. The spleen serves as a reservoir for blood, and filters or purifies the blood and lymph fluid that flows through it. If the spleen is damaged or removed, the individual is more susceptible to infections.

## Immune System Details

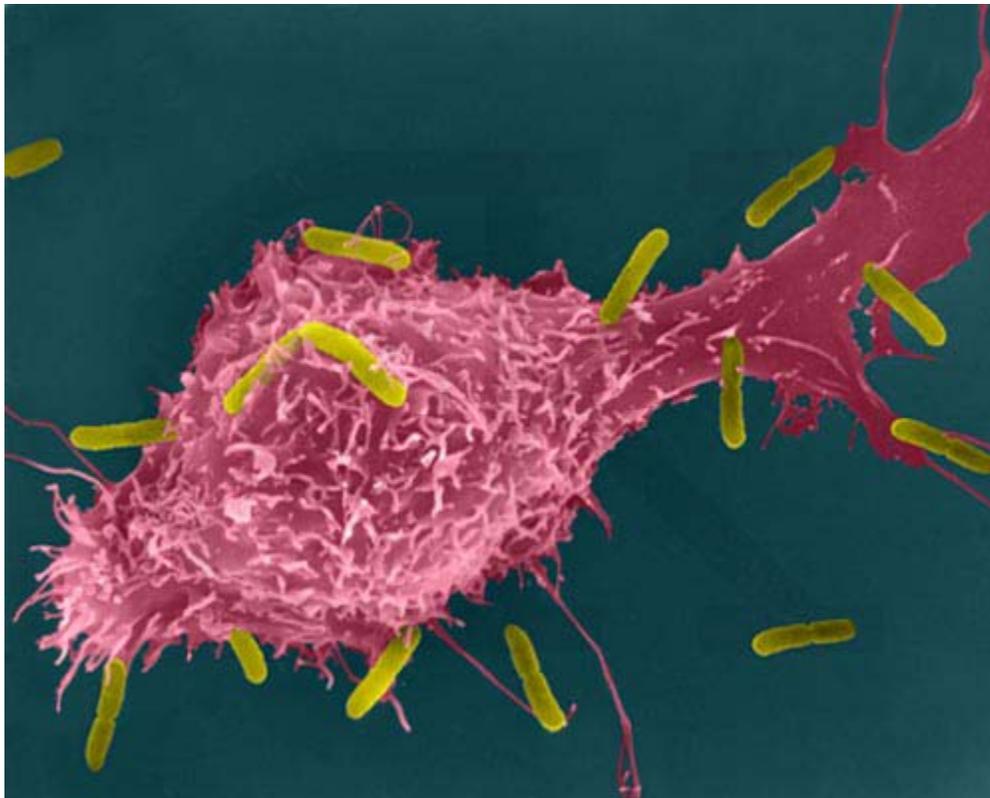
The immune system also generates specific responses to specific invaders.

The immune system is more effective than the nonspecific methods, and has a memory component that improves response time when an invader of the same type (or species) is again encountered.

Immunity results from the production of antibodies specific to a given antigen (antibody-generators, located on the surface of an invader). Antibodies bind to the antigens on invaders and kill or inactivate them in several ways. Most antibodies are themselves proteins or are a mix of protein and polysaccharides. Antigens can be any molecule that causes antibody production.

## Lymphocytes

White blood cells known as lymphocytes arise from by mitosis of stem cells in the bone marrow. Some lymphocytes migrate to the thymus and become T cells that circulate in the blood and are associated with the lymph nodes and spleen. B cells remain in the bone marrow and develop before moving into the circulatory and lymph systems. B cells produce antibodies.

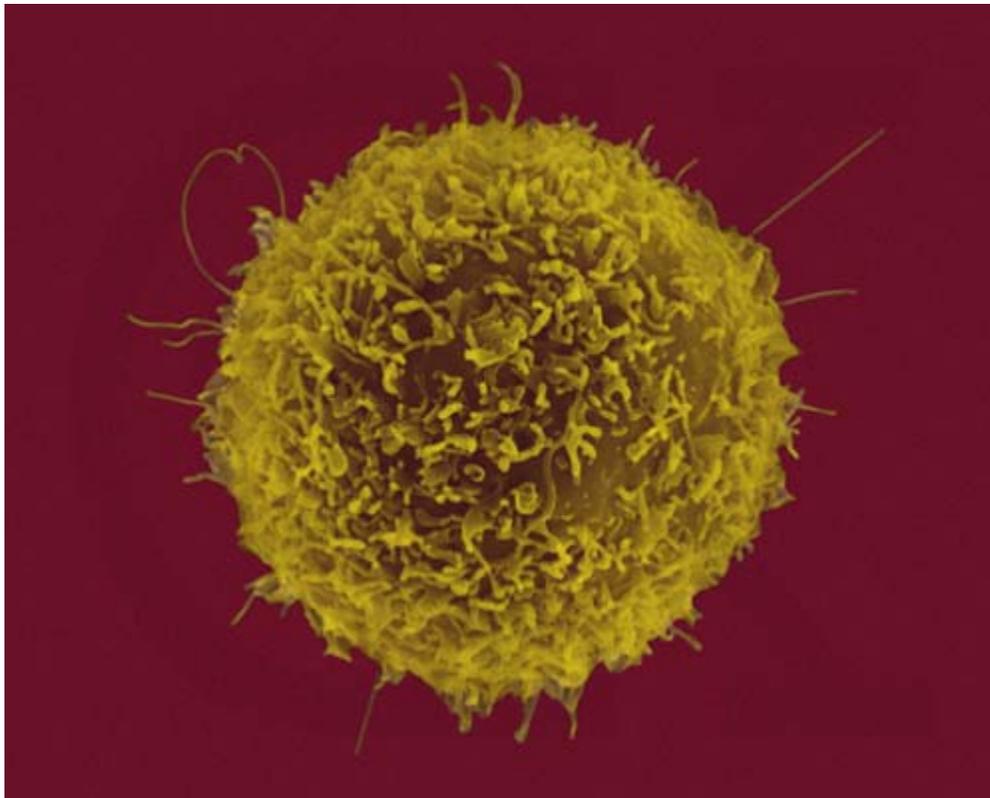


**Macrophage** Attacking *E.coli* (SEM x8,800). This image is copyright Dennis Kunkel at [www.DennisKunkel.com](http://www.DennisKunkel.com),

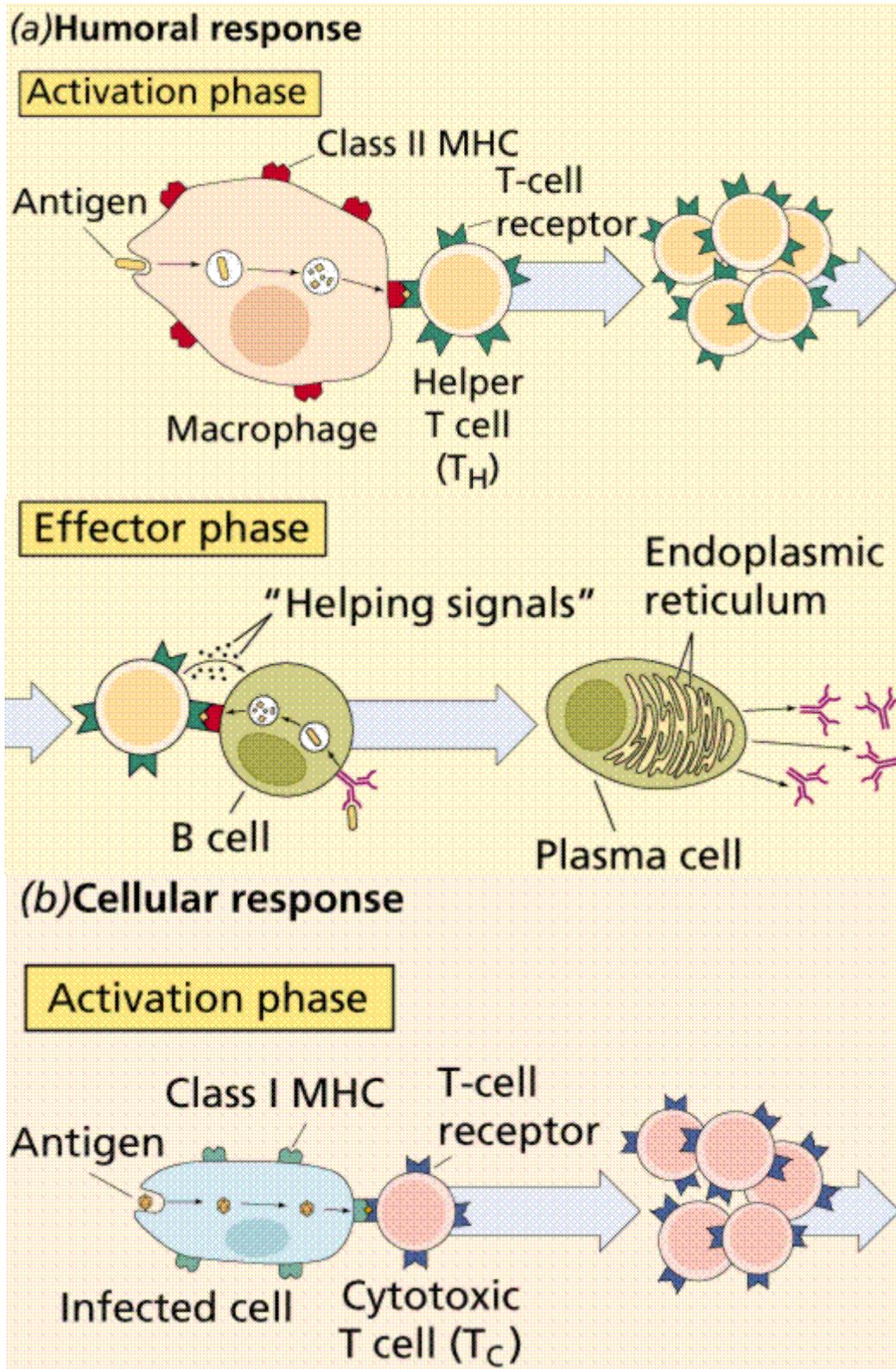
Macrophages are white blood cells that continually search for foreign (nonself) antigenic molecules, viruses, or microbes. When found, the macrophages engulf and destroys them. Small fragments of the antigen are displayed on the outer surface of the macrophage plasma membrane.

### **Antibody-mediated (humoral immunity)**

Antibody-mediated (humoral) immunity is regulated by B cells and the antibodies they produce. Cell-mediated immunity is controlled by T cells. Antibody-mediated reactions defend against invading viruses and bacteria. Cell-mediated immunity concerns cells in the body that have been infected by viruses and bacteria, protect against parasites, fungi, and protozoans, and also kill cancerous body cells.



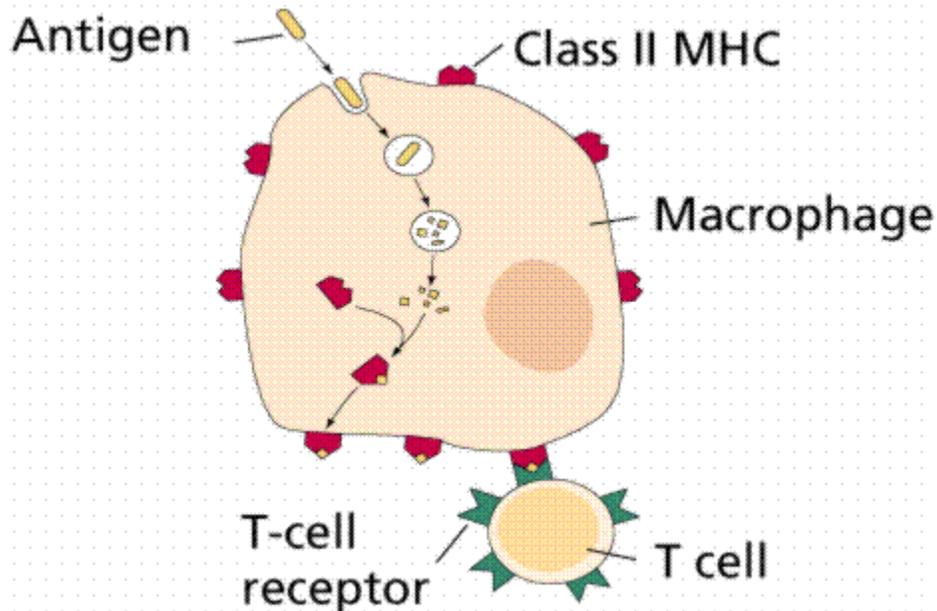
Human T-lymphocyte (SEM x12,080). This image is copyright Dennis Kunkel at [www.DennisKunkel.com](http://www.DennisKunkel.com).



The cell-mediated immune responses. Images from Purves et al., Life: The Science of Biology, 4th Edition, by Sinauer Associates ([www.sinauer.com](http://www.sinauer.com)) and WH Freeman ([www.whfreeman.com](http://www.whfreeman.com)).

## Helper T Cells

Helper T cells are macrophages that become activated when they encounter the antigens now displayed on the macrophage surface. Activated T cells identify and activate B cells.



The display path of an antigen as accomplished by a macrophage. Image from Purves et al., [Life: The Science of Biology](#), 4th Edition, by Sinauer Associates ([www.sinauer.com](http://www.sinauer.com)) and WH Freeman ([www.whfreeman.com](http://www.whfreeman.com))

## B Cells

B cells divide, forming plasma cells and B memory cells. Plasma cells make and release between 2000 and 20,000 antibody molecules per second into the blood for the next four or five days. B memory cells live for months or years, and are part of the immune memory system.

<http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookIMMUN.html>

## The Renal System

The most important organs in the renal system are the kidneys. The renal system also encompasses the ureters, urinary bladder, ureter, but these are not nearly as important and sophisticated in structure and function as the kidneys are. The kidneys have four important roles in the body.

### 1. Regulate fluid levels in the body

The kidneys are essential in regulating the fluid content of the body. Urine constitutes a high percentage of the total daily fluid loss. In patients with kidney failure, the plasma and total body fluid volumes can increase, leading to hypertension and oedema.

### 2. Regulate the fluid composition of the body

The kidneys also contribute to regulating fluid composition in the body by controlling the fluid composition of urine. By forming highly osmolar urine, for example, the kidneys can help reducing plasma osmolarity. Reducing the excretion rate of a substance, on the other hand, can cause it to accumulate in plasma.

### 3. Rid the body of toxic substances

Many drugs and toxic substances are cleared by the kidneys in normal individuals. When there is kidney failure these products can accumulate, producing serious and prolonged effects.

### 4. Hormonal activation and release

The kidneys are responsible for the first step in the activation pathway of vitamin D, an important hormone for  $\text{Ca}^{2+}$  absorption. Kidney failure will cause a reduction in the active form of vitamin D, which will cause a reduction in  $\text{Ca}^{2+}$ .

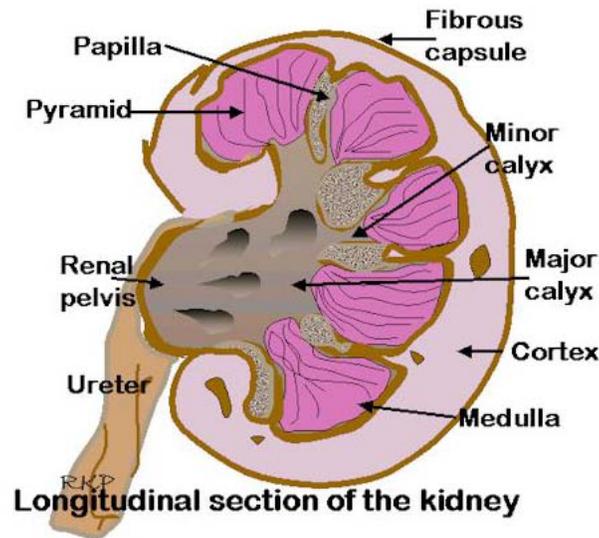
The kidneys are also responsible for the production and release of the hormone erythropoietin, which is important for stimulating stem cells to produce mature blood cells. In kidney failure, this hormone will not be produced, and anaemia might occur.

Renin is another hormone produced by the kidneys. It is the initial hormone of what is called the renin-angiotensin system, which is important in the response to low blood pressure and serum sodium levels.

Retrieved from [http://en.wikibooks.org/wiki/Human\\_Physiology\\_-\\_The\\_renal\\_system](http://en.wikibooks.org/wiki/Human_Physiology_-_The_renal_system)

## Anatomy of the Kidney

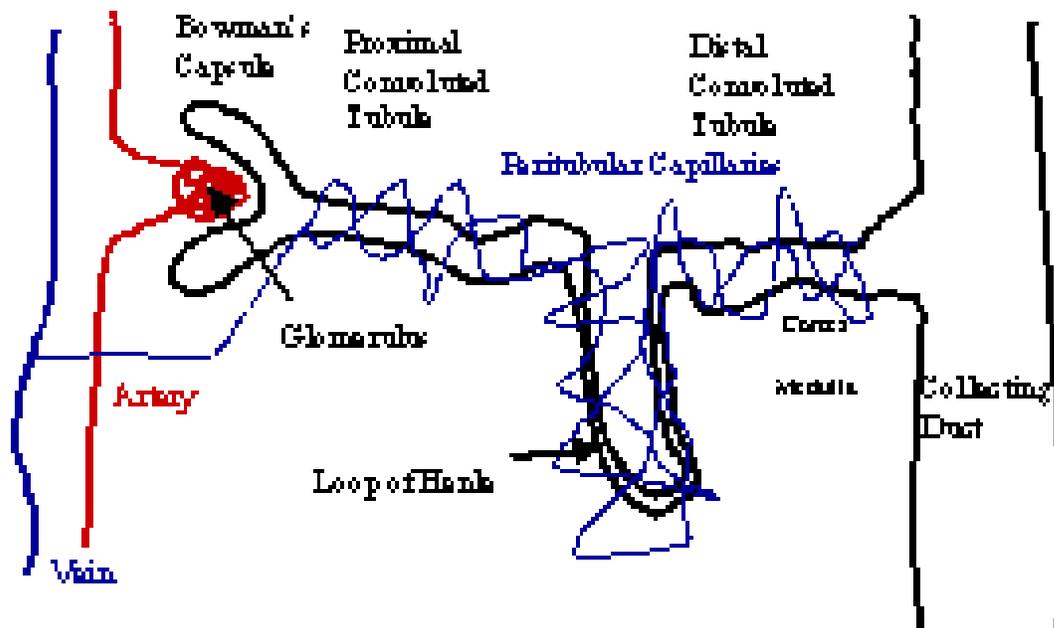
The kidneys are two small retroperitoneal organs composed of an outer cortex and an inner medulla.



[http://ucsfagrc.org/supplements/renal/02\\_anatomy.html](http://ucsfagrc.org/supplements/renal/02_anatomy.html)

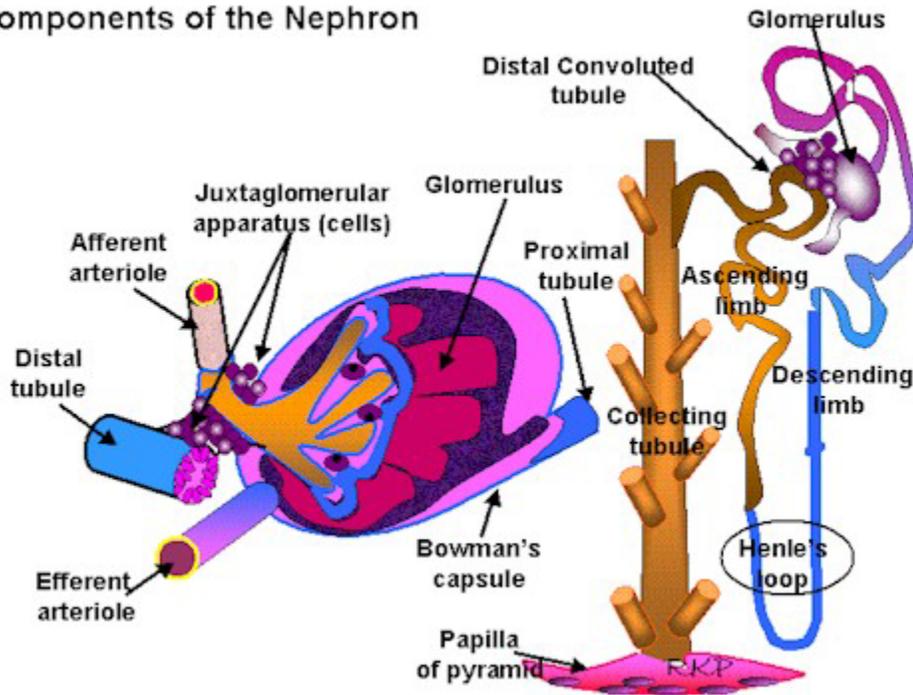
Knowledge of the kidneys' structure and function is necessary for an understanding of how changes that occur with aging make older adults vulnerable to certain health problems.

## Nephrons – the functional unit of the kidney



<http://www.people.vcu.edu/~mikuleck/courses/renal/sld004.htm>

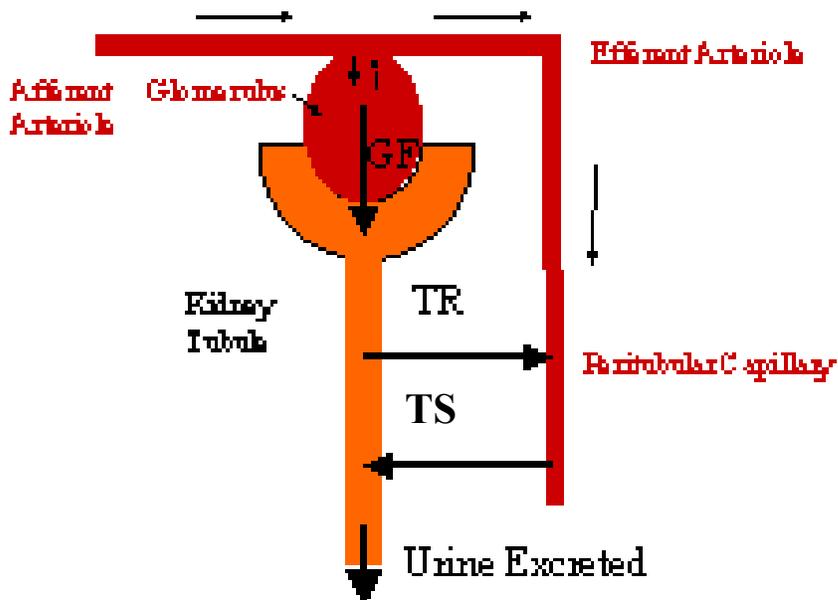
### Components of the Nephron



[http://ucsfagr.org/supplements/renal/02\\_anatomy.html](http://ucsfagr.org/supplements/renal/02_anatomy.html)

### Three basic renal processes

- Glomerular Filtration: Filtering of blood into tubule forming the primitive urine
- Tubular Reabsorption: Absorption of substances needed by body from tubule to blood
- Tubular Secretion: Secretion of substances to be eliminated from the body into the tubule from the blood



<http://www.people.vcu.edu/~mikuleck/courses/renal/sld004.htm>

## **Endocrine System**

[http://kidshealth.org/parent/general/body\\_basics/endocrine.html](http://kidshealth.org/parent/general/body_basics/endocrine.html)

Although we rarely think about them, the glands of the endocrine system and the hormones they release influence almost every cell, organ, and function of our bodies. The endocrine system is instrumental in regulating mood, growth and development, tissue function, and metabolism, as well as sexual function and reproductive processes.

In general, the endocrine system is in charge of body processes that happen slowly, such as cell growth. Faster processes like breathing and body movement are monitored by the nervous system. But even though the nervous system and endocrine system are separate systems, they often work together to help the body function properly.

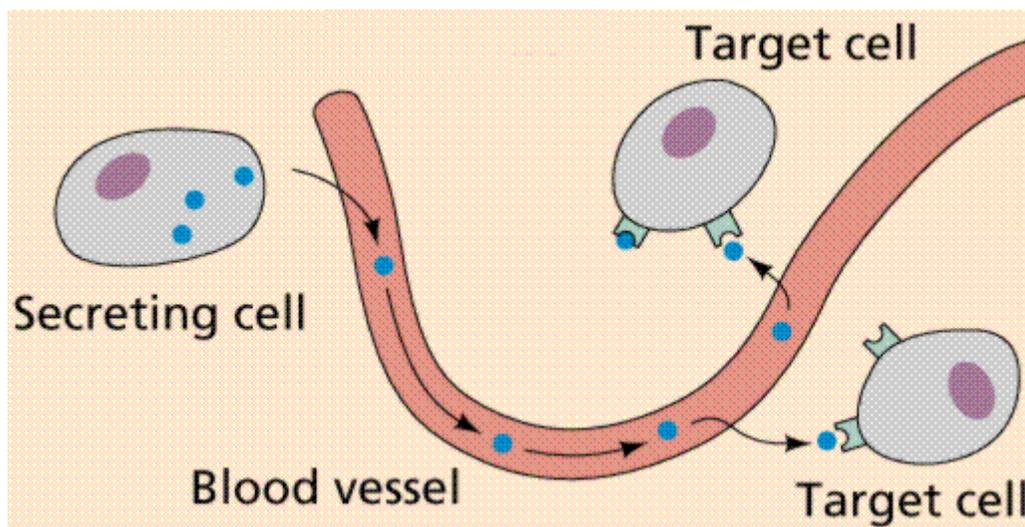
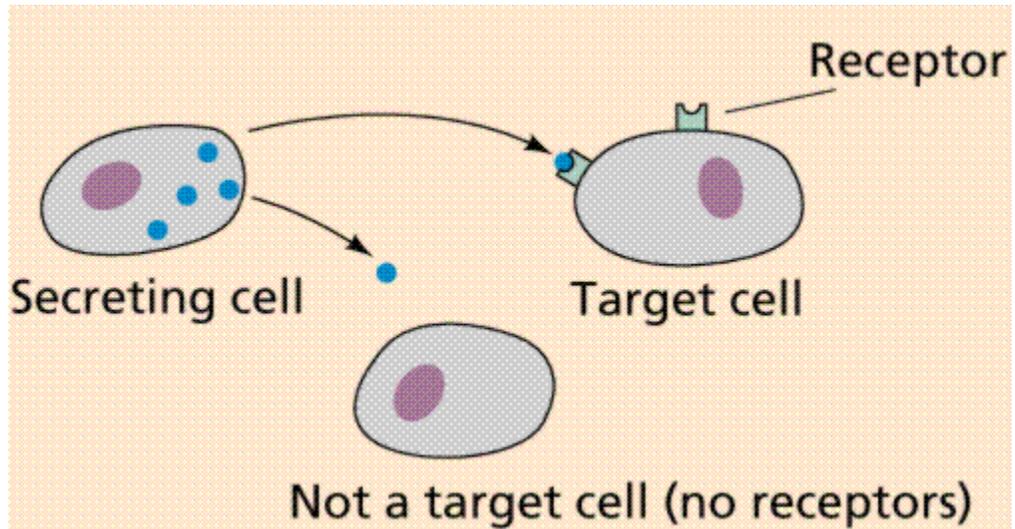
### **What Is the Endocrine System?**

The foundations of the endocrine system are the hormones and glands. As the body's chemical messengers, **hormones** transfer information and instructions from one set of cells to another. Although many different hormones circulate throughout the bloodstream, each one affects only the cells that are genetically programmed to receive and respond to its message. Hormone levels can be influenced by factors such as stress, infection, and changes in the balance of fluid and minerals in blood.

## Hormones

<http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookENDOCR.html>

The endocrine system is a collection of glands that secrete chemical messages we call hormones. These signals are passed through the blood to arrive at a target organ, which has cells possessing the appropriate receptor. Exocrine glands (not part of the endocrine system) secrete products that are passed outside the body. Sweat glands, salivary glands, and digestive glands are examples of exocrine glands.

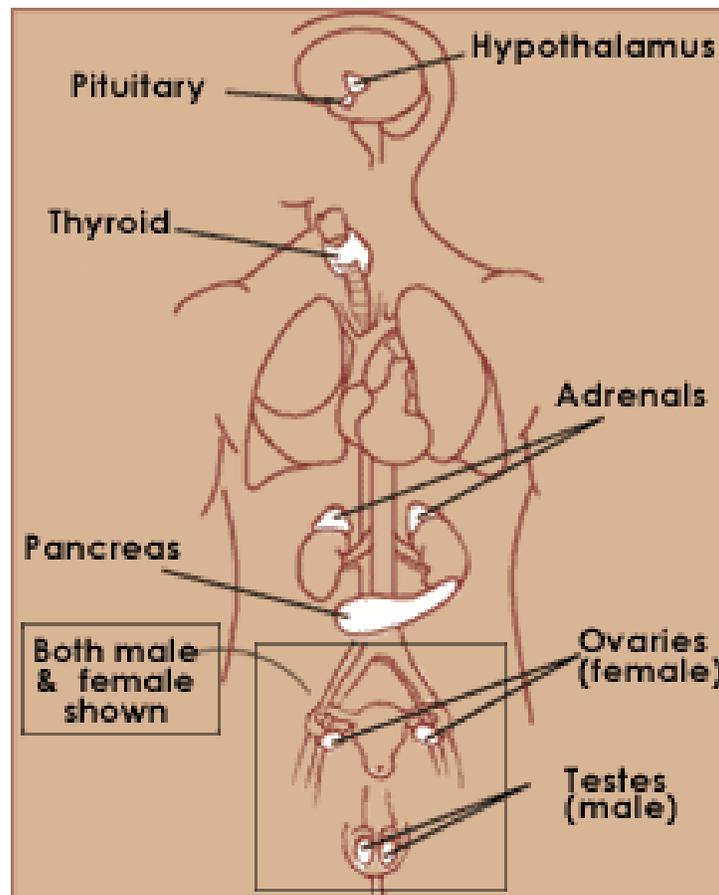


The roles of hormones in selecting target cells and delivering the hormonal message. Images from Purves et al., *Life: The Science of Biology*, 4th Edition, by Sinauer Associates ([www.sinauer.com](http://www.sinauer.com)) and WH Freeman ([www.whfreeman.com](http://www.whfreeman.com)).

Hormones are grouped into three classes based on their structure:

1. steroids
2. peptides
3. amines

A **gland** is a group of cells that produces and secretes, or gives off, chemicals. A gland selects and removes materials from the blood, processes them, and secretes the finished chemical product for use somewhere in the body. Some types of glands release their secretions in specific areas. For instance, **exocrine glands**, such as the sweat and salivary glands, release secretions in the skin or inside of the mouth. **Endocrine glands**, on the other hand, release more than 20 major hormones directly into the bloodstream where they can be transported to cells in other parts of the body.



The major glands that make up the human endocrine system are the hypothalamus, pituitary, thyroid, parathyroids, adrenals, pineal body, and the reproductive glands, which include the ovaries and testes. The pancreas is also part of this hormone-secreting system, even though it is also associated with the digestive system because it also produces and secretes digestive enzymes. Although the endocrine glands are the body's main hormone producers, some non-endocrine organs - such as the brain, heart, lungs, kidneys, liver, thymus, skin, and placenta - also produce and release hormones.

The **hypothalamus**, a collection of specialized cells that is located in the lower central part of the brain, is the primary link between the endocrine and nervous systems. Nerve cells in the hypothalamus control the pituitary gland by producing chemicals that either stimulate or suppress hormone secretions from the pituitary.

Although it is no bigger than a pea, the **pituitary gland**, located at the base of the brain just beneath the hypothalamus, is considered the most important part of the endocrine system. It's often called the "master gland" because it makes hormones that control several other endocrine glands. The production and secretion of pituitary hormones can be influenced by factors such as emotions and seasonal changes. To accomplish this, the hypothalamus relays information sensed by the brain (such as environmental temperature, light exposure patterns, and feelings) to the pituitary.

The tiny pituitary is divided into two parts: the anterior lobe and the posterior lobe. The **anterior lobe** regulates the activity of the thyroid, adrenals, and reproductive glands. Among the hormones it produces are:

- **growth hormone**, which stimulates the growth of bone and other body tissues and plays a role in the body's handling of nutrients and minerals
- **prolactin**, which activates milk production in women who are breastfeeding
- **thyrotropin**, which stimulates the thyroid gland to produce thyroid hormones
- **corticotropin**, which stimulates the adrenal gland to produce certain hormones

The pituitary also secretes **endorphins**, chemicals that act on the nervous system to reduce sensitivity to pain. In addition, the pituitary secretes hormones that signal the ovaries and testes to make sex hormones. The pituitary gland also controls ovulation and the menstrual cycle in women.

The **posterior lobe** of the pituitary releases **antidiuretic hormone**, which helps control body water balance through its effect on the kidneys and urine output; and **oxytocin** (pronounced: ahk-see-toe-sin), which triggers the contractions of the uterus that occur during labor.

The **thyroid**, located in the front part of the lower neck, is shaped like a bowtie or butterfly and produces the thyroid hormones **thyroxine** and **triiodothyronine**. These hormones control the rate at which cells burn fuels from food to produce energy. As the level of thyroid hormones increases in the bloodstream, so does the speed at which chemical reactions occur in the body. Thyroid hormones also play a key role in bone growth and the development of the brain and nervous system in children. The production and release of thyroid hormones is controlled by **thyrotropin**, which is secreted by the pituitary gland.

Attached to the thyroid are four tiny glands that function together called the **parathyroids**. They release **parathyroid hormone**, which regulates the level of calcium in the blood with the help of **calcitonin**, which is produced in the thyroid.

The body has two triangular **adrenal glands**, one on top of each kidney. The adrenal glands have two parts, each of which produces a set of hormones and has a different function. The outer part, the **adrenal cortex**, produces hormones called **corticosteroids** that influence or regulate salt and water balance in the body, the body's response to stress, metabolism, the immune system, and sexual development and function. The inner part, the **adrenal medulla**, produces **catecholamines**, such as **epinephrine**. Also called adrenaline, epinephrine increases blood pressure and heart rate when the body experiences stress. (Epinephrine injections are often used to counteract a severe allergic reaction.)

The **pineal body**, also called the pineal gland, is located in the middle of the brain. It secretes **melatonin**, a hormone that may help regulate the wake-sleep cycle.

The **gonads** are the main source of sex hormones. In males, they are located in the scrotum. Male gonads, or **testes**, secrete hormones called **androgens**, the most important of which is **testosterone**. These hormones regulate body changes associated with sexual development, including enlargement of the penis, the growth spurt that occurs during **puberty**, and the appearance of other male secondary sex characteristics such as deepening of the voice, growth of facial and pubic hair, and the increase in muscle growth and strength. Working with hormones from the pituitary gland, testosterone also supports the production of sperm by the testes.

The female gonads, the **ovaries**, are located in the pelvis. They produce eggs and secrete the female hormones **estrogen** and **progesterone**. Estrogen is involved in the development of female sexual features such as breast growth, the accumulation of body fat around the hips and thighs, and the growth spurt that occurs during puberty. Both estrogen and progesterone are also involved in pregnancy and the regulation of the menstrual cycle.

The **pancreas** produces (in addition to others) two important hormones, **insulin** and **glucagon**. They work together to maintain a steady level of glucose, or sugar, in the blood and to keep the body supplied with fuel to produce and maintain stores of energy.

### **What Does the Endocrine System Do?**

Once a hormone is secreted, it travels from the endocrine gland through the bloodstream to the cells designed to receive its message. These cells are called target cells. Along the way to the target cells, special proteins bind to some of the hormones. The special proteins act as carriers that control the amount of hormone that is available to interact with and affect the target cells. Also, the target cells have receptors that latch onto only specific hormones, and each hormone has its own receptor, so that each hormone will communicate only with specific target cells that possess receptors for that hormone. When the hormone reaches its target cell, it locks onto the cell's specific receptors and these hormone-receptor combinations transmit chemical instructions to the inner workings of the cell.

When hormone levels reach a certain normal or necessary amount, further secretion is controlled by important body mechanisms to maintain that level of hormone in the blood. This regulation of hormone secretion may involve the hormone itself or another substance in the blood related to the hormone. For example, if the thyroid gland has secreted adequate amounts of thyroid hormones into the blood, the pituitary gland senses the normal levels of thyroid hormone in the bloodstream and adjusts its release of thyrotropin, the pituitary hormone that stimulates the thyroid gland to produce thyroid hormones. Another example is parathyroid hormone, which increases the level of calcium in the blood. When the blood calcium level rises, the parathyroid glands sense the change and decrease their secretion of parathyroid hormone. This turnoff process is called a negative feedback system.

## Things That Can Go Wrong With the Endocrine System

Too much or too little of any hormone can be harmful to the body. For example, if the pituitary gland produces too much growth hormone, a child may grow excessively tall. If it produces too little, a child may be abnormally short. Controlling the production of or replacing specific hormones can treat many endocrine disorders in children and adolescents, some of which include:

**Adrenal insufficiency.** This condition is characterized by decreased function of the adrenal cortex and the consequent underproduction of adrenal corticosteroid hormones. The symptoms of adrenal insufficiency may include weakness, fatigue, abdominal pain, nausea, dehydration, and skin changes. Doctors treat adrenal insufficiency by giving replacement corticosteroid hormones.

**Cushing syndrome.** Excessive amounts of glucocorticoid hormones in the body can lead to Cushing syndrome. In children, it most often results when a child takes large doses of synthetic corticosteroid drugs (such as prednisone) to treat autoimmune diseases such as lupus. If the condition is due to a tumor in the pituitary gland that produces excessive amounts of corticotropin and stimulates the adrenals to overproduce corticosteroids, it's known as Cushing disease. Symptoms may take years to develop and include obesity, growth failure, muscle weakness, easy bruising of the skin, acne, high blood pressure, and psychological changes. Depending on the specific cause, doctors may treat this condition with surgery, radiation therapy, chemotherapy, or drugs that block the production of hormones.

**Type 1 diabetes.** When the pancreas fails to produce enough insulin, type 1 diabetes (previously known as juvenile diabetes) occurs. Symptoms include excessive thirst, hunger, urination, and weight loss. In children and teens, the condition is usually an autoimmune disorder in which specific immune system cells and antibodies produced by the child's immune system attack and destroy the cells of the pancreas that produce insulin. The disease can cause long-term complications including kidney problems, nerve damage, blindness, and early coronary heart disease and stroke. To control their blood sugar levels and reduce the risk of developing diabetes complications, children with this condition need regular injections of insulin.

**Type 2 diabetes.** Unlike type 1 diabetes, in which the body can't produce normal amounts of insulin, in type 2 diabetes the body is unable to respond to insulin normally. Children and teens with the condition tend to be overweight, and it is believed that excess body fat plays a role in the insulin resistance that characterizes the disease. In fact, the rising prevalence of this type of diabetes in children has paralleled the dramatically increasing rates of obesity among children and teens in recent years. The symptoms and possible complications of type 2 diabetes are basically the same as those of type 1. Some kids and teens can control their blood sugar level with dietary changes, exercise, and oral medications, but many will need to take insulin injections like patients with type 1 diabetes.

**Growth hormone problems.** Too much growth hormone in children who are still growing will make their bones and other body parts grow excessively, resulting in gigantism. This rare condition is usually caused by a pituitary tumor and can be treated by removing the tumor. In contrast, when the pituitary gland fails to produce adequate amounts of growth hormone, a child's growth in height is impaired. Hypoglycemia (low blood sugar) may also occur in children with growth hormone deficiency, particularly in infants and young children with the condition.

**Hyperthyroidism.** Hyperthyroidism is a condition in which the levels of thyroid hormones in the blood are excessively high. Symptoms may include weight loss, nervousness, tremors, excessive sweating, increased heart rate and blood pressure, protruding eyes, and a swelling in the neck from an enlarged thyroid gland (goiter). In children and teens the condition is usually caused by Graves' disease, an autoimmune disorder in which specific antibodies produced by the child's immune system stimulate the thyroid gland to become overactive. The disease may be controlled with medications or by removal or destruction of the thyroid gland through surgery or radiation treatments.

**Hypothyroidism.** Hypothyroidism is a condition in which the levels of thyroid hormones in the blood are abnormally low. Thyroid hormone deficiency slows body processes and may lead to fatigue, a slow heart rate, dry skin, weight gain, constipation, and, in children, slowing of growth and delayed puberty. Hashimoto thyroiditis, which results from an autoimmune process that damages the thyroid and blocks thyroid hormone production, is the most common cause of hypothyroidism in children. Infants can also be born with an absent or underdeveloped thyroid gland, resulting in hypothyroidism. The condition can be treated with oral thyroid hormone replacement.

**Precocious puberty.** Body changes associated with puberty may occur at an abnormally young age in some children if the pituitary hormones that stimulate the gonads to produce sex hormones rise prematurely. An injectable medication is available that can suppress the secretion of these pituitary hormones (known as gonadotropins) and arrest the progression of sexual development in most of these children.