Skin

The skin is the body’s largest organ, made of water, protein, fats and minerals. Your skin protects your body from germs and regulates body temperature. Nerves in the skin help you feel sensations like hot and cold.

Your skin, along with your hair, nails, oil glands and sweat glands, is part of the integumentary (in-TEG-you-ME~~I~~NT-a-ree) system. “Integumentary” means a body’s outer covering.

What are the layers of the skin?

Three layers of tissue make up the skin:

- **Epidermis**, the top layer.
- **Dermis**, the middle layer.
- **Hypodermis**, the bottom or fatty layer.

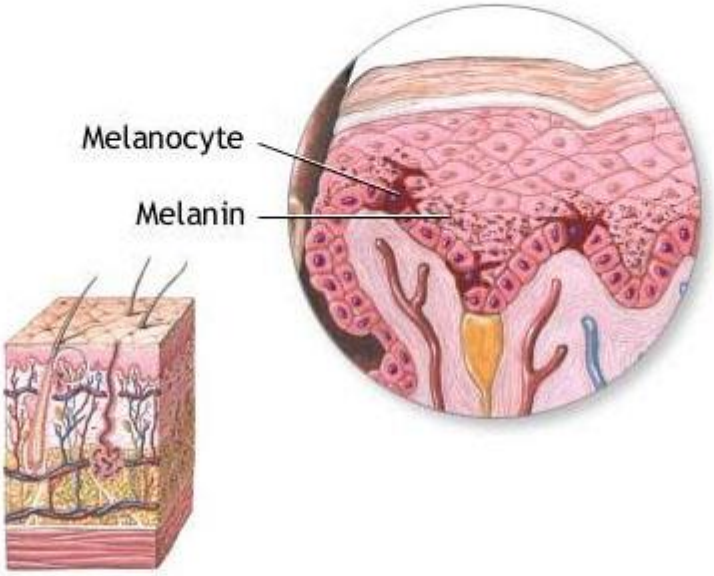
The Epidermis

The epidermis is the outermost layer of the skin, and protects the body from the environment. The thickness of the epidermis varies in different types of skin; it is only .05 mm thick on the eyelids, and is 1.5 mm thick on the palms and the soles of the feet. The epidermis contains the melanocytes (the cells in which melanoma develops), the Langerhans' cells (involved in the immune system in the skin), Merkel cells and sensory nerves. The epidermis layer itself is made up of five sublayers that work together to continually rebuild the surface of the skin:

Epidermis is the top layer of the skin that you can see and touch. Keratin, a protein inside skin cells, makes up the skin cells and, along with other proteins, sticks together to form this layer. The epidermis:

- **Acts as a protective barrier**: The epidermis keeps bacteria and germs from entering your body and bloodstream and causing infections. It also protects against rain, sun and other elements.
- **Makes new skin**: The epidermis continually makes new skin cells. These new cells replace the approximately 40,000 old skin cells that your body sheds every day. You have new skin every 30 days.
- **Protects your body**: Langerhans cells in the epidermis are part of the body’s immune system. They help fight off germs and infections.
- **Provides skin color**: The epidermis contains melanin, the pigment that gives skin its color. The amount of melanin you have determines the color of your skin,

hair and eyes. People who make more melanin have darker skin and may tan more quickly.

- The Basal Cell Layer
- The basal layer is the innermost layer of the epidermis, and contains small round cells called basal cells. The basal cells continually divide, and new cells constantly push older ones up toward the surface of the skin, where they are eventually shed. The basal cell layer is also known as the stratum germinativum due to the fact that it is constantly germinating (producing) new cells.
- 

- The basal cell layer contains cells called melanocytes. Melanocytes produce the skin coloring or pigment known as melanin, which gives skin its tan or brown color and helps protect the deeper layers of the skin from the harmful effects of the sun. Sun exposure causes melanocytes to increase production of melanin in order to protect the skin from damaging ultraviolet rays, producing a suntan. Patches of melanin in the skin cause birthmarks, freckles and age spots. Melanoma develops when melanocytes undergo malignant transformation.
- Merkel cells, which are tactile cells of neuroectodermal origin, are also located in the basal layer of the epidermis.
- The Squamous Cell Layer
- The squamous cell layer is located above the basal layer, and is also known as the stratum spinosum or "spiny layer" due to the fact that the cells are held together with spiny projections. Within this layer are the basal cells that have been pushed upward, however these maturing cells are now called squamous cells, or keratinocytes. Keratinocytes produce keratin, a tough, protective protein that makes up the majority of the structure of the skin, hair, and nails.

- The squamous cell layer is the thickest layer of the epidermis, and is involved in the transfer of certain substances in and out of the body. The squamous cell layer also contains cells called Langerhans cells. These cells attach themselves to antigens that invade damaged skin and alert the immune system to their presence.
- The Stratum Granulosum & the Stratum Lucidum
- The keratinocytes from the squamous layer are then pushed up through two thin epidermal layers called the stratum granulosum and the stratum lucidum. As these cells move further towards the surface of the skin, they get bigger and flatter and adhere together, and then eventually become dehydrated and die. This process results in the cells fusing together into layers of tough, durable material, which continue to migrate up to the surface of the skin.
- The Stratum Corneum
- The stratum corneum is the outermost layer of the epidermis, and is made up of 10 to 30 thin layers of continually shedding, dead keratinocytes. The stratum corneum is also known as the "horny layer," because its cells are toughened like an animal's horn. As the outermost cells age and wear down, they are replaced by new layers of strong, long-wearing cells. The stratum corneum is sloughed off continually as new cells take its place, but this shedding process slows down with age. Complete cell turnover occurs every 28 to 30 days in young adults, while the same process takes 45 to 50 days in elderly adults.

What does the dermis (middle layer of skin) do?

The dermis is the middle layer of the skin. The dermis contains the following:

- Blood vessels
- Lymph vessels
- Hair follicles
- Sweat glands
- Collagen bundles
- Fibroblasts
- Nerves
- Sebaceous glands

The dermis is held together by a protein called collagen. This layer gives skin flexibility and strength. The dermis also contains pain and touch receptors. The dermis is located beneath the epidermis and is the thickest of the three layers of the skin (1.5 to 4 mm thick), making up approximately 90 percent of the thickness of the skin. The main functions of the dermis are to regulate temperature and to supply the epidermis with nutrient-saturated blood. Much of the body's water supply is stored within the dermis. This layer contains most of the skins' specialized cells and structures, including:

- **BloodVessels**
  The blood vessels supply nutrients and oxygen to the skin and take away cell waste and cell products. The blood vessels also transport the vitamin D produced in the skin back to the rest of the body.
- **LymphVessels**
  The lymph vessels bathe the tissues of the skin with lymph, a milky substance that contains the infection-fighting cells of the immune system. These cells work to destroy any infection or invading organisms as the lymph circulates to the lymph nodes.
- **HairFollicles**
  The hair follicle is a tube-shaped sheath that surrounds the part of the hair that is under the skin and nourishes the hair.
- **SweatGlands**
  The average person has about 3 million sweat glands. Sweat glands are classified according to two types:
  1. Apocrine glands are specialized sweat glands that can be found only in the armpits and pubic region. These glands secrete a milky sweat that encourages the growth of the bacteria responsible for body odor.
  2. Eccrine glands are the true sweat glands. Found over the entire body, these glands regulate body temperature by bringing water via the pores to the surface of the skin, where it evaporates and reduces skin temperature. These glands can produce up to two liters of sweat an hour, however, they secrete mostly water, which doesn't encourage the growth of odor-producing bacteria.
- **Sebaceousglands**
  Sebaceous, or oil, glands, are attached to hair follicles and can be found everywhere on the body except for the palms of the hands and the soles of the feet. These glands secrete oil that helps keep the skin smooth and supple. The oil also helps keep skin waterproof and protects against an overgrowth of bacteria and fungi on the skin.
- **NerveEndings**
  The dermis layer also contains pain and touch receptors that transmit sensations of pain, itch, pressure and information regarding temperature to the brain for

interpretation. If necessary, shivering (involuntary contraction and relaxation of muscles) is triggered, generating body heat.

- **CollagenandElastin**
  The dermis is held together by a protein called collagen, made by fibroblasts. Fibroblasts are skin cells that give the skin its strength and resilience. Collagen is a tough, insoluble protein found throughout the body in the connective tissues that hold muscles and organs in place. In the skin, collagen supports the epidermis, lending it its durability. Elastin, a similar protein, is the substance that allows the skin to spring back into place when stretched and keeps the skin flexible.

The dermis layer is made up of two sublayers:

The Papillary Layer

The upper, papillary layer, contains a thin arrangement of collagen fibers. The papillary layer supplies nutrients to select layers of the epidermis and regulates temperature. Both of these functions are accomplished with a thin, extensive vascular system that operates similarly to other vascular systems in the body. Constriction and expansion control the amount of blood that flows through the skin and dictate whether body heat is dispelled when the skin is hot or conserved when it is cold.

The Reticular Layer

The lower, reticular layer, is thicker and made of thick collagen fibers that are arranged in parallel to the surface of the skin. The reticular layer is denser than the papillary dermis, and it strengthens the skin, providing structure and elasticity. It also supports other components of the skin, such as hair follicles, sweat glands, and sebaceous glands.

The Subcutis

The subcutis is the innermost layer of the skin, and consists of a network of fat and collagen cells. The subcutis is also known as the hypodermis or subcutaneous layer, and functions as both an insulator, conserving the body's heat, and as a shock-absorber, protecting the inner organs. It also stores fat as an energy reserve for the body. The blood vessels, nerves, lymph vessels, and hair follicles also cross through this layer. The thickness of the subcutis layer varies throughout the body and from person to person.

The dermis makes up 90% of skin’s thickness. This middle layer of skin:

- **Has collagen and elastin**: Collagen is a protein that makes skin cells strong and resilient. Another protein found in the dermis, elastin, keeps skin flexible. It also helps stretched skin regain its shape.
- **Grows hair**: The roots of hair follicles attach to the dermis.
- **Keeps you in touch**: Nerves in the dermis tell you when something is too hot to touch, itchy or super soft. These nerve receptors also help you feel pain.
- **Makes oil**: Oil glands in the dermis help keep the skin soft and smooth. Oil also prevents your skin from absorbing too much water when you swim or get caught in a rainstorm.
- **Produces sweat**: Sweat glands in the dermis release sweat through skin pores. Sweat helps regulate your body temperature.
- **Supplies blood**: Blood vessels in the dermis provide nutrients to the epidermis, keeping the skin layers healthy.

What does the hypodermis (bottom layer of skin) do?

The bottom layer of skin, or hypodermis, is the fatty layer. The hypodermis:

- **Cushions muscles and bones**: Fat in the hypodermis protects muscles and bones from injuries when you fall or are in an accident.
- **Has connective tissue**: This tissue connects layers of skin to muscles and bones.
- **Helps the nerves and blood vessels**: Nerves and blood vessels in the dermis (middle layer) get larger in the hypodermis. These nerves and blood vessels branch out to connect the hypodermis to the rest of the body.
- **Regulates body temperature**: Fat in the hypodermis keeps you from getting too cold or hot.
- The subcutaneous fat layer is the deepest layer of skin. It consists of a network of collagen and fat cells. It helps conserve the body's heat and protects the body from injury by acting as a shock absorber.

Sweat gland

Introduction & Definition

Small tubular skin structures called sweat glands, also called sudoriparous or sudoriferous glands, are responsible for producing sweat.

Exocrine glands are found all over the surface of the body and are responsible for sweat production. The integument’s appendages are the sweat glands. There are apocrine and eccrine sweat glands. They vary in distribution, embryology, and function.

Most of the body is covered in thin skin with sweat glands, hair arrector muscles, hair follicles, and sebaceous glands. Simple, curled, tubular glands known as eccrine sweat glands are found all over the body, although they are most prominent on the bottoms of the feet.

The production of foul-smelling perspiration is a characteristic of apocrine sweat glands, also known as odoriferous sweat glands.

Structure

Typically, sweat glands consist of a secretory unit found in the subcutaneous tissue or deep dermis and a duct that extends from the secretory unit to the body surface through which sweat or other secretory products are delivered.

The gland is entirely encircled by adipose tissue, and the secretory coil or base is deeply embedded in the lower dermis and hypodermis. The contractile myoepithelial cells surrounding the secretory coils in both types of sweat glands facilitate the excretion of secretory contents.

The autonomic nervous system and the circulating hormones regulate the secretory activities of epithelial cells and the contractions of myoepithelial cells. The acrosyringium refers to the distal or apical portion of the duct that opens to the surface of the skin.

Numerous nerve fibres enter each sweat gland, branch off into groups of one or more axons and encircle each tubule of the secretory coil. Sweat tubules are connected by capillaries.

Types and Functions

Eccrine

There are eccrine sweat glands throughout the body, except few places such as ear canal, lips, etc. They are ten times less smaller than apocrine sweat glands, do not penetrate the dermis as profoundly, and secrete directly onto the skin's surface.

Sweat, often known as sensible perspiration, is the transparent secretion generated by eccrine sweat glands. Since sweat is derived from blood plasma, it primarily contains water and some electrolytes. Sweat has a salty taste because it contains sodium chloride.

There are three primary functions of eccrine glands:

- **Thermoregulation:** Sweat lowers body temperature by cooling the skin's surface via evaporation and evaporative heat loss.

- **Excretion:** The secretion of eccrine sweat glands can be an essential pathway for eliminating electrolytes and water.
- **Protection:** Eccrine sweat gland secretion contributes to maintaining the acid layer of the skin, which helps guard against bacterial and other harmful organisms invading the skin.

Apocrine

Apocrine glands produce sweat into the hair follicle's pilary canal rather than directly onto the skin's surface. There are apocrine sweat glands in the armpit, areola, perineum, ear, and eyelids. Compared to eccrine glands, the secretory area is more significant.

The apocrine sweat glands are dormant before puberty; hormonal changes during puberty lead the glands to enlarge and start functioning. Thicker than eccrine sweat, the produced component feeds the bacteria living on the skin.

Apoeccrine

Some human sweat glands, known as apoeccrine glands, exhibit traits that make them difficult to identify as either eccrine or apocrine. They are smaller than apocrine but larger than eccrine glands. Their secretory component has a large segment, like apocrine glands, and a narrow section resembling secretory coils in eccrine glands.

Apoeccrine glands are essential in axillary sweating because they secrete more sweat than eccrine and apocrine glands combined. They consistently produce a thin, watery sweat, like eccrine glands.

The elimination of particular excretory wastes is facilitated by sweat, even though its primary purpose is to assist in producing a cooling effect on the skin's surface. The sweat glands secrete watery fluid in perspiration, containing minor amounts of urea, lactic acid, and other substances. Certain toxins can be removed from the body through the sebaceous and sweat glands in the skin.

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What is protein digestion?

Protein is one of the essential compounds in our body. Human saliva contains the enzymes lipase and amylase. They mainly digest fats and carbohydrates. As soon as we start chewing, protein digestion begins. Protein digestion first breaks the complex molecule into peptides containing various amino acids and then into individual amino acids.
Q2

Where does protein digestion begin and end?

Protein digestion begins when you first start chewing and concludes in the small intestine. To produce more proteins, the body reuses amino acids.
Q3

Digestion of both starch and protein is done by ___________.

Digestion of both starch and protein is done by the pancreatic juice. The pancreatic enzymes include lipase, which breaks down triglycerides into fatty acids and monoglycerides. Trypsin, chymotrypsin, and elastase all break down proteins. Amylase breaks down the excess complex carbohydrates into monosaccharides. Therefore, the digestion of carbohydrates, protein, and fat is unattainable without the pancreas.
Q4

How are proteins in your food digested?

Proteins undergo hydrolysis, which converts them into amino acids, during digestion. The amino acids are dissolved in our blood and transported to organs and tissues. The amino acids are either converted into energy or put together into proteins using condensation polymerization.
Q5

How are proteins digested in small intestine?

The partially digested meal, or chyme, next passes into the small intestine, where intestinal fluids and pancreatic enzymes exist. The pancreatic juices and intestinal secretions induce several chemical reactions. These include the enzymes chymotrypsin, trypsin, and elastase, which break down the protein into smaller peptides. Carboxypeptidase, aminopeptidase, and dipeptidase break down the peptides into free amino acids, which can then enter the bloodstream. The pepsin enzyme dissolves peptide bonds and helps in the initial stages of protein digestion in the stomach.

What is the main function of a nephron?

A nephron is the structural and functional unit of the kidney. It regulates the concentration of water and minerals such as sodium by filtering the blood and reabsorbing the important nutrients.

Q2

How does a nephron filter blood?

A nephron consists of a filter called glomerulus and a tubule. The glomerulus filters the fluid and waste products holding back the blood cells and large molecules, especially proteins.

Q3

What are the two main parts of a nephron structure?

The two main parts of a nephron structure include:

- Renal tubule
- Renal corpuscle

Q4

Where are the nephrons located?

The nephrons are located in the cortex and medulla of the kidney. The cortex contains the renal corpuscle, distal convoluted tubule and proximal convoluted tubule. Whereas, the medulla contains the loop of Henle and collecting ducts.

Q5

What is the cup-shaped structure surrounding the renal corpuscle called?

The cup-shaped structure surrounding the renal corpuscle is known as the Bowman’s capsule or glomerulus that helps in blood filtration.

Q1

How many sweat glands are there in the human body?

Eccrine sweat glands are present on both glabrous (found on the palms and soles of the body) and non-glabrous (hairy) skin in humans, numbering about ~2-4 million in total. The density of the glands varies around the surface area of the body.

Q2

What nerves supply sweat glands?

Cholinergic fibres that deliver impulses in response to shifts in the core body temperature provide sympathetic innervation to eccrine sweat glands, producing sweat.

The hypothalamic thermoregulatory centre mediates the sympathetic innervation of the sweat glands.

A healthy body functions best at an internal temperature of about 37°C (98.6°F). But everyone has their own individual "normal" body temperature, which may be slightly higher or lower. Our bodies also constantly adapt their temperature to environmental conditions. It goes up when we exercise, for instance. And it is lower at night, and higher in the afternoon than in the morning.

Our internal body temperature is regulated by a part of our brain called the hypothalamus. The hypothalamus checks our current temperature and compares it with the normal temperature of about 37°C. If our temperature is too low, the hypothalamus makes sure that the body generates and maintains heat. If, on the other hand, our current body temperature is too high, heat is given off or sweat is produced to cool the skin.

Strictly speaking, body temperature refers to the temperature in the hypothalamus and in the vital internal organs. Because we cannot measure the temperature inside these organs, temperature is taken on parts of the body that are more accessible. But these measurements are always slightly inaccurate.

People get a fever when their brain sets the body temperature higher than normal. This may happen as a reaction to germs such as viruses or bacteria, but it can also happen as a reaction to substances that are made by the body, such as prostaglandins. Our body produces prostaglandins to fight off germs.

A body temperature of 38°C (100.4°F) or more is considered to be a fever. Temperatures above 39.5°C (103.1°F) are considered to be a high fever, and very high fever is defined as any temperature above 41°C (105.8°F). A temperature between 37.5°C and 38°C is an elevated body temperature.

The regulation of body temperature doesn't always work perfectly in younger children. Compared to older children and adults, they also sweat less when it is warm, and it takes longer for them to start sweating. That is why they are more likely to react with a fever. Babies and young children have a higher body temperature than older children. This is because their body surface area is larger in relation to their body weight. Their metabolism is more active too. Newborns usually have an average body temperature of 37.5°C.

Thermoregulation is the biological mechanism responsible for maintaining a steady internal body temperature. The thermoregulation system includes the hypothalamus in the brain, as well as the sweat glands, skin, and circulatory system.

The human body maintains a temperature of about 98.6°F (37°C) using various physical processes. These include sweating to lower the body temperature, shivering to raise it, and narrowing or relaxing blood vessels to alter blood flow.

Thermoregulation is how mammals maintain a steady body temperature. Unlike reptiles, which have a body temperature that changes with their environment, mammals need to keep a consistent body temperature all of the time. In humans, the healthy range is within a degree or two of 98.6°F (37°C).

When thermoregulation works as it should, the body performs at its optimum level. A temperature that is too high or too low can affectTrusted Source the:

- heart
- circulatory system
- brain
- gastrointestinal tract
- lungs
- kidneys
- liver

How does thermoregulation work in humans?

The human body uses three mechanismsTrusted Source of thermoregulation:

- efferent responses
- afferent sensing
- central control

Efferent responses are the behaviors that humans can engage in to regulate their own body temperature. Examples of efferent responses include putting on a coat before going outside on cold days and moving into the shade on hot days.

Afferent sensing involves a system of temperature receptors around the body to identify whether the core temperature is too hot or cold. The receptors relay the information to the hypothalamus, which is part of the brain.

The hypothalamus acts as the central control, using the information it receives from afferent sensing to produce hormones that alter body temperature. These hormones send signals to various parts of the body so that it can respond to heat or cold in the following ways:

Response to heat	**Response to cold**
sweating	shivering, or thermogenesis
dilated blood vessels, known as vasodilation	constricted blood vessels, known as vasoconstriction
decrease in metabolism	increase in metabolism

Thermoregulation disorders

The healthy temperature range for the human body is very narrow. If the body cannot maintain a temperature within this range, thermoregulation disorders can develop.

Hyperthermia

Hyperthermia occurs when the body's heat-regulating mechanisms fail, and the body temperature becomes too high. There are several typesTrusted Source of hyperthermia, including:

- heat cramps, which present as heavy sweating and muscle cramps during exercise
- heat exhaustion, which is more serious and causes a range of symptoms
- heatstroke, which is a medical emergency

The symptoms of heat exhaustion are:

- sweating
- pale, clammy, or cold skin
- fast or weak pulse
- tiredness
- weakness

- dizziness
- nausea or vomiting
- headaches
- fainting

Heatstroke causes similar symptoms, but with some important differences, including:

- flushed or hot skin, which may be dry or damp
- a fast, strong pulse
- a body temperature of 103°F (39.4°C) or higher

Learn more about the differences between heat exhaustion and heatstroke.

Hypothermia

Hypothermia occurs when the body loses heat faster than it can produce it. Prolonged exposure to cold temperatures can cause hypothermia. The symptoms includeTrusted Source:

- shivering
- confusion
- exhaustion or feeling very tired
- fumbling hands
- slurred speech
- drowsiness
- memory loss

In young children and babies, hypothermia causes cold skin, which may be bright red in those with light skin tones.

What can impair thermoregulation?

Several factors can affect thermoregulation, including environmental conditions, diseases, and certain medications.

Extreme weather

Extreme weather can significantly affect the body's ability to regulate temperature.

Hypothermia occurs when a person has exposure to extremely cold temperatures for an extended period. In these instances, the body loses heat quickly, and heat production cannot keep up, causing a dip in body temperature.

In addition to freezing temperatures, hypothermia can also occur in cool temperatures if sweat, rain, or submersion in cold water chills someone.

On the opposite end of the spectrum, hot weather and extended exposure to the sun can cause the body to overheat. Instead of losing more heat than it can produce, the body heats up faster than it can cool itself down.

Someone may also developTrusted Source hyperthermia in warm temperatures as a result of:

- drinking insufficient fluids
- wearing heavy, insulating clothing
- visiting overcrowded places
- exerting themself physically, especially outside

Infections

When a person has an infection, harmful microorganisms invade the body and multiply. These pathogens can thrive at typical body temperatures, but an increased temperature makes it more difficult for some of them to survive.

For this reason, part of the immune response to infections is often a fever. This occurs when the body raises its own temperature in an effort to kill infection-causing organisms. Many doctors recommend letting a fever run its course so that the body can adequately protect itself.

However, problems can arise if the body temperature becomes too high, hindering necessary functions. If someone has a fever above 105°F (40.5Trusted SourceTrusted Source°C)Trusted Source that does not decrease with medication, they should seek urgent medical attention. A doctor will treat the fever to try to lower the body temperature to a safe level.

Age

Infants and older adults have a higher riskTrusted Source of thermoregulation disorders. The reason for this is that these individuals have a lower muscle mass, a decreased shiver reflex, and lower immunity.

Older adults tend to have a lower body temperature and may not develop fevers when they contract a viral or bacterial illness. Sometimes, they can develop hypothermia instead.

Other diseases

Other diseases can also affect thermoregulation. These include:

Endocrine disorders

The endocrine system comprises glands and organs that produce hormones, such as the pancreas, thyroid, pituitary gland, and adrenal glands. If something interferes with hormone production, it can affect body temperature.

For example, an underactive thyroid, or hypothyroidism, can lead to a lower body temperature, while an overactive thyroid, called hyperthyroidism, can cause a higher body temperature.

Central nervous system (CNS) disorders

The CNS includes the brain, spinal cord, and nerves. Conditions that affect the CNS can interfere with thermoregulation by impairing afferent sensing and central control. Some examples of these conditions includeTrusted Source:

- brain injuries
- spinal cord injuries
- neurological diseases, such as Parkinson's or multiple sclerosis
- tumors

Medications

Certain medications can disrupt thermoregulation as a side effect, causing a temporary rise in body temperature. Some people refer to this as “drug fever.” Examples of medications that can have this effect include:

- antimicrobials, such as antibiotics
- nonsteroidal anti-inflammatory drugs (NSAIDs)
- first generation anticonvulsants
- antidepressants

Usually, thermoregulation quickly returns to normal when a person stops taking the drug. People should always speak with a doctor before changing the dosage of their medication.