

Snake Anatomy

Know your snake inside and out with this snake anatomy introduction.

By Douglas Mader, M.S., DVM, DABVP

Page 1 of 7

Anatomical Road Map

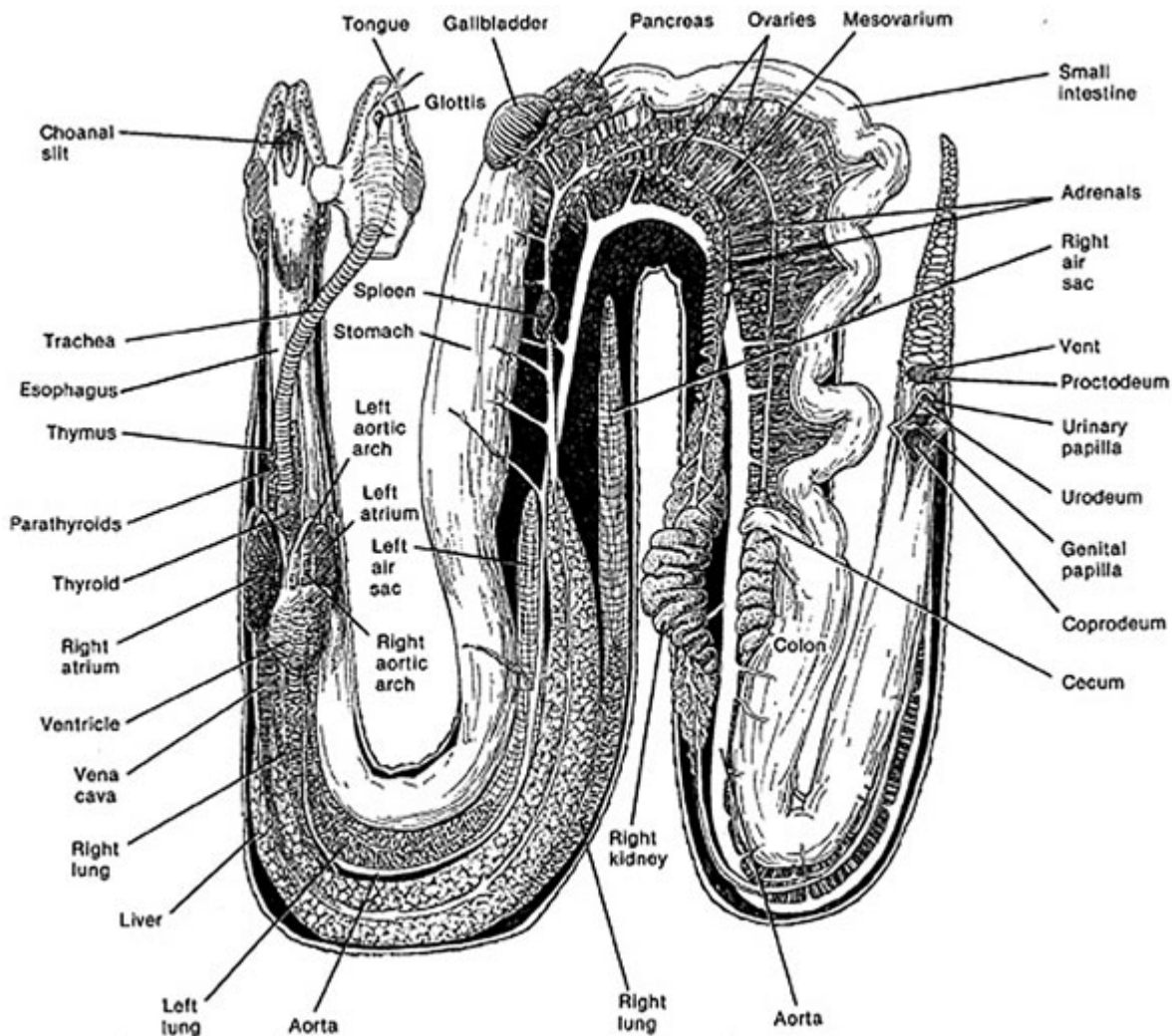
Because snakes are basically one long tube, it is possible to partition their main anatomical parts into sections. If you lay the snake out straight on a table with its head on your left, going from left to right, the first 25 percent of the snake consists of the head, the esophagus and trachea, and the heart. Those are the major organs and parts.

In the second quarter, about 26 to 50 percent of the snake, are the top of the lungs, the liver, and then three-fourths of the way down the liver, the stomach.

In the third quarter, about 51 to 75 percent of the snake, you encounter the gall bladder, the spleen and the pancreas (or the splenopancreas depending on the species). Following this triad of organs you will find the gonads (testes or ovaries). Coursing between these structures is the small intestine, and adjacent to them is the right lung (and in some species the left lung, as well).

In the last quarter, the last 76 to 100 percent of the snake, you'll find the junction between the small and large intestine, the cecum (if present), the kidneys (right in front of the left) and the cloaca.

If you can remember this anatomical road map for snakes, you'll be a better herpetologist.



Outer Beauty

Most reptiles have four legs. Snakes, however, do not have legs. They also lack a pectoral girdle (shoulder bones) and — with the exception of the boids, which retain a vestigial pelvis and external spurs — they also lack a pelvic girdle (rear leg support).

As with all reptiles, snakes are covered with scales, which offer protection from desiccation and injury. They can be smooth and shiny, such as a python's scales, or rough and dull, such as a hognose snake's scales. The outer, thin layer is the epidermis, which is shed on a regular basis. The inner, thicker, more developed layer is the dermis. This dermal layer is filled with chromatophores, the pigment cells that give snakes their color.

Scales are formed largely of keratin derived from the epidermis. As the snake grows, which they do their entire lives (growth just slows as they get older), this outer layer of epidermis sheds off. New scales grow beneath the older outer scales. Eventually, the outer layer sheds off, usually in one piece and inverted as if it were a sock pulled from the top down. This shedding process is called ecdysis.

In general, if the shed skin comes off in shards, it may be a sign of some underlying problem. The snake's health or husbandry issues, such as improper environmental temperatures, humidity or caging furniture, might be to blame.

Scales are attached to each other by soft skin — generally not noticed from the outside — that folds inward between each adjacent scale. Scales cannot stretch, but when a snake eats a large meal, the skin folds are pulled out straight to expand the surface area.

Basically two types of scales are on a snake. Its top and sides are generally covered by smaller scales. These can juxtapose or overlap like shingles on a roof. The bottom of the snake is covered by short but very wide scales that look like rungs on a ladder. These special scales are called scutes. They form the belly of the snake and are integral in the snake's ability to move.

Snakes have two eyes, but they do not have eyelids. A spectacle, a transparent scale that is actually part of the skin, protects each eye. When a snake undergoes ecdysis, it sloughs this spectacle off along with its skin. Spectacles turn a light, semiopaque blue as the snake prepares to shed. Herpetologists call this condition "in the blue." This is normal, but snakekeepers who have never seen it happen before may mistake it for a problem. Immediately before the actual shed, spectacles again become clear. This means that the shed is imminent.

It is imperative that shed skin be examined every time a snake sheds to make sure these spectacles come off. Occasionally one does not, and this results in a retained eye cap. Like other shedding problems, a retained spectacle can be a sign of a health or husbandry problem. In addition, if a retained spectacle is not removed, it can cause problems with the animal's vision and can potentially damage the eye.



This ball python's eyes are tinted blue because it is about to shed. Yellow arrows point to labial pits, which contain heat-sensing organs.

Snakes lack an external ear, but they do have an internal ear, and they are capable of detecting low frequency sounds ranging from 100 to 700 hertz. (A young person with normal hearing can hear frequencies between approximately 20 and 20,000 hertz.) A snake's inner ear also allows it to detect motion, static position and sound waves traveling through the ground.

Another external feature found in boids and crotalids are the labial pits, a series of openings along the upper and lower lips that contain heat-sensing organs. These pits help snakes acquire prey, and they warn them of possible predators nearby.

All snakes have a single vent, which is an excretory opening. This vent opens on the bottom of the snake near the tail and leads into a compound structure called the cloaca, which will be discussed later.

Head Features

A snake's head contains the eyes, nostrils, mouth (and structures within), brain, and a special sensory structure called the vomeronasal or Jacobson's organ. Its paired openings are just in front of the snake's choana, the open slitlike structure on the upper inside of the reptile's mouth. All snakes have a forked tongue. When they flick their tongue, the tips pick up minute scent particles in the air and place them in direct contact with this organ. In essence, this is how a snake smells.

Snakes' teeth line the inner surfaces of the upper and lower jawbones (maxilla and mandible, respectively). Nonvenomous snakes have four rows of upper teeth: two rows attached to the maxillary (outer) bones, and two rows attached to the palatine and pterygoid (inner) bones. Only two rows are on the lower jaw; one is attached to each mandible. Most venomous snakes substitute fangs for the maxillary teeth. These fangs can either be in the front of the mouth, such as in a rattlesnake, or the back of the mouth, such as in a hognose snake.

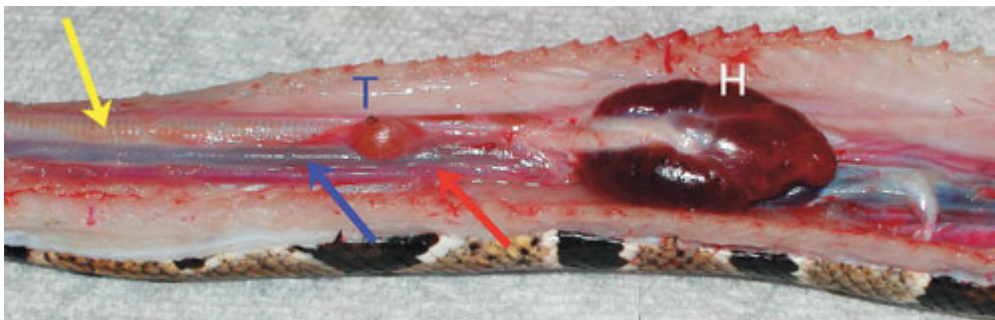
Snakes use their teeth for grasping, not chewing. Their teeth are recurved, so once a prey item is bitten, the only direction for it to move is toward the snake's stomach.

Snake Respiratory System Anatomy

Respiratory System

Snakes have a small opening just behind the tongue called the glottis, which opens into the trachea, or windpipe. Unlike what mammals have, the reptile glottis is always closed, forming a vertical slit, unless the snake takes a breath. A small piece of cartilage just inside the glottis vibrates when the snake forcefully expels air from its lungs. This produces a snake's characteristic hiss. Snakes are able to extend their glottis out the side of their mouth while they eat, which allows for respiration while they consume large prey items.

The trachea is a long, strawlike structure supported by cartilaginous rings. These rings are incomplete in that the snake looks more like a C than an O. A thin membrane completes the open part of the C. This configuration is also seen in lizards, but the function of the incomplete rings remains unknown. The trachea usually terminates just in front of the heart, and at this point it splits into the two primary bronchi, airways that direct air into either the left or right lung.

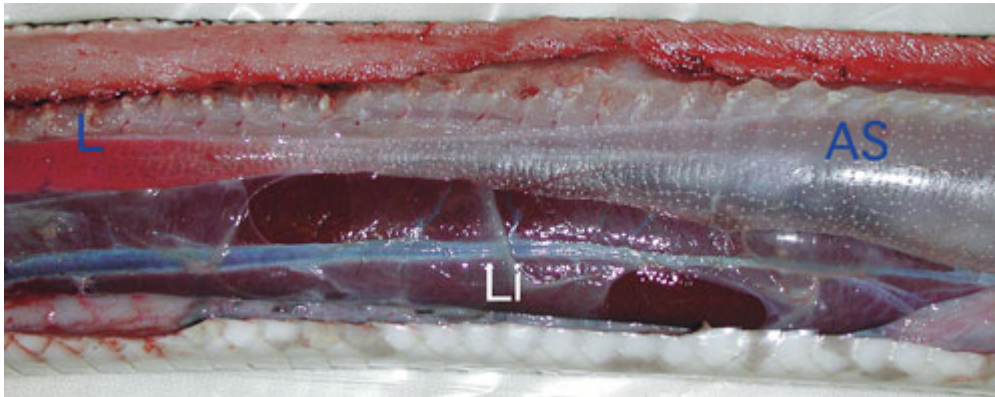


In the first quarter of the snake are the trachea (yellow arrow), thyroid (T), jugular vein (blue arrow), carotid artery (red arrow) and heart (H).

In most snakes the short left bronchus terminates in a vestigial, or rudimentary, left lung. The size and functional capacity of this lung varies depending on the species. It can be complete in some of the water snakes where it is used for hydrostatic purposes. The right bronchus terminates in the functional right lung.

Snakes breathe principally by contracting muscles between their ribs. Unlike mammals, they lack a diaphragm, the large smooth muscle responsible for inspiration and expiration between the chest and abdomen. Inspiration is an active process (muscles contract), whereas expiration is passive (muscles relax).

The portion of a snake's lung nearest its head has a respiratory function; this is where oxygen exchange occurs. The lung portion nearest the tail, regardless of the lung's size, is more of an air sac. The inside of these sac portions look more like the inside of a balloon than a lung. There is no exchange of respiratory gases.

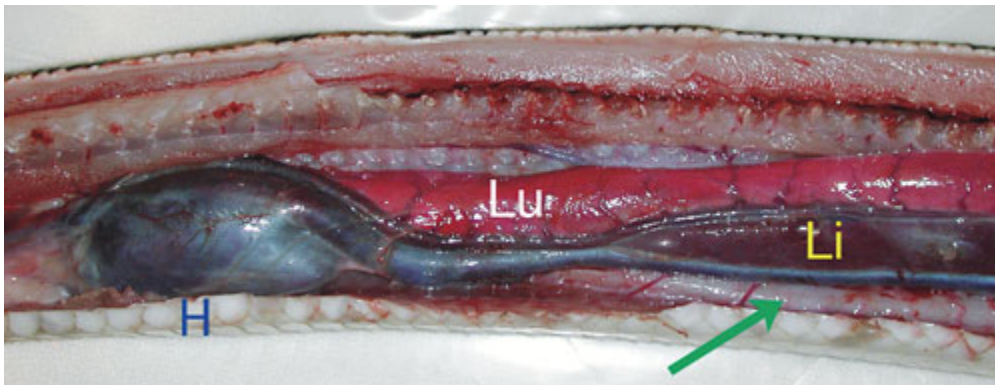


This close-up picture shows the lung's respiratory portion (L), its air sac portion (AS) and the liver (Li).

Snake Cardiovascular System Anatomy

Cardiovascular System

The three-chambered reptilian heart is composed of two atria, which receive blood from the lungs and body, and a large ventricle, which pumps blood into arteries. This heart is evolutionarily more basic than the mammalian four-chambered heart, but because of divisions and valves within the ventricle, the snake heart still functions as a four-chambered heart very similar to its mammalian counterparts.



Within the second quarter of the snake are the heart (H), lung (Lu), liver (Li) and esophagus (green arrow).

Snakes and other reptiles have an interesting adaptation to their cardiovascular system that mammals lack. It is called the renal portal system. In this type of system blood from the animal's tail passes through the kidneys first before returning to the general body circulation.

This may be significant, especially in sick reptiles, because many of the drugs used to treat infections are eliminated from the body through the kidneys. With certain drugs injected into a reptile's tail or rear legs, the renal portal system may cause the medication to lose some of its effectiveness. Veterinarians must understand the drugs they are using and how best to administer them.

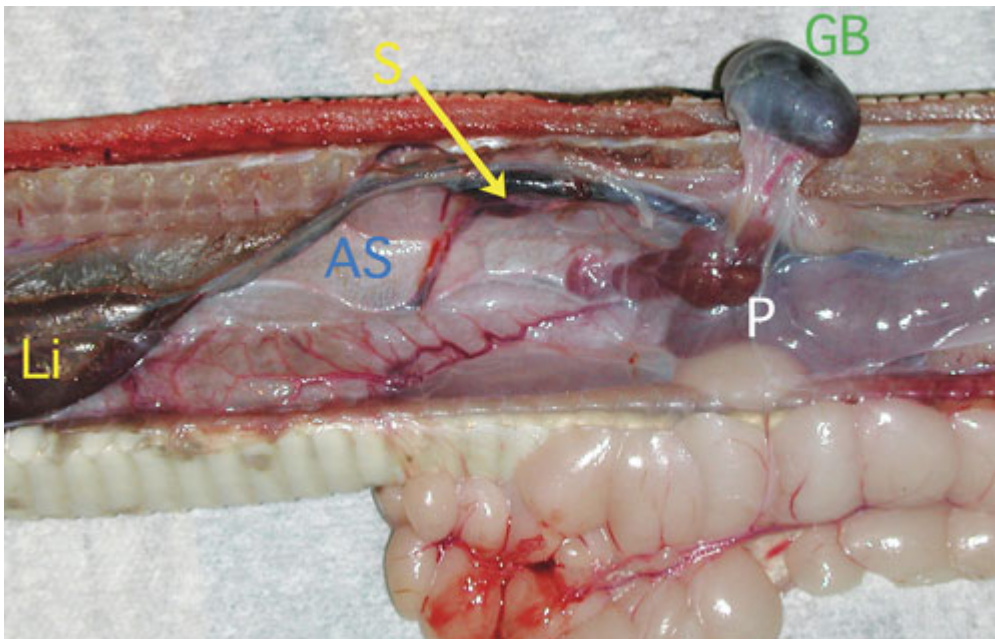
Snake Immune System Anatomy

Immune and Endocrine Systems

Snakes, unlike mammals, do not have lymph nodes. When a snake is sick, you won't see swollen lymph nodes under the chin or arm pits like you might in people, dogs and cats. Snakes have a lymphatic system, but it just is not as easy to find. In some species, such as boids, a tissue similar to tonsils is found in the esophagus.

The spleen is a small, spherical, reddish organ located between the gall bladder and the pancreas. In younger animals it functions in the creation of red blood cells, and in older animals it helps in the destruction of cells and in blood storage. In most snakes the spleen is usually tightly adhered to the pancreas, and the two organs are often collectively referred to as the "splenopancreas."

The pancreas is found just behind the gall bladder and just after the end of the stomach. It is a major endocrine organ. Among many things, it helps regulate the body's blood-glucose levels and produces digestive enzymes.



Found in the third quarter of the snake are the liver (Li), air sac (AS), pancreas (P), gall bladder (GB) and spleen (S, yellow arrow).

Interestingly, a snake's gall bladder is not associated with the liver like it is mammals, lizards and turtles.

The single- or double-lobed thymus, a spherical, reddish-pink structure, is found just in front of the thyroid gland, which is just in front of the base of the heart. The thymus is one of the organs responsible for producing immune cells that fight infection.

The thyroid gland is responsible for the production of thyroid hormone, a key in metabolism, and it is responsible for the normal shedding cycle.

Reptiles have one or two pairs of parathyroid glands found either just in front or just behind of the thyroid. These difficult-to-find glands regulate calcium and phosphorus levels in the body. Because most snakes eat whole prey, the parathyroid glands do not play as significant a role in disease as they do in other reptiles, such as the green iguana.

About three-fourths of the way down a snake's body are a pair of adrenal glands commonly called "stress glands." These glands are found closely associated with the gonads (testes or ovaries) and urogenital structures (kidneys and ureters). The adrenals are pinkish, tubelike structures found adjacent to, or just in front of, the gonads. These glands are very important and function similar to the mammalian glands. When a reptile is stressed, the adrenal glands produce corticosterone, a type of steroid. This is important because the hormone suppresses an animal's immune system, thus making it more susceptible to disease.

Snake Gastrointestinal Tract Anatomy

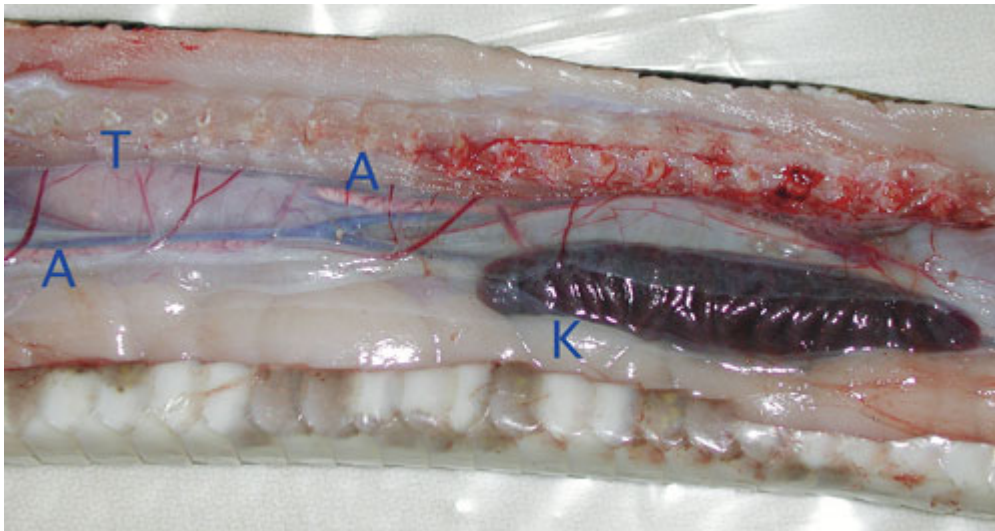
Gastrointestinal Tract

For the most part, the mouth does little more than catch food for the snake. Very little chewing, if any, occurs. After a snake catches its prey, its kinetic (moveable) skull "walks" the jaws in a stepwise fashion, ratcheting the prey deeper into the throat until ultimately it's swallowed.

Saliva produced has little digestive significance; its role is mostly to serve as a lubricant. The esophagus courses alongside the trachea and extends from the back of the mouth to the stomach. Its longitudinal folds allow for great stretchability to accommodate large food items.

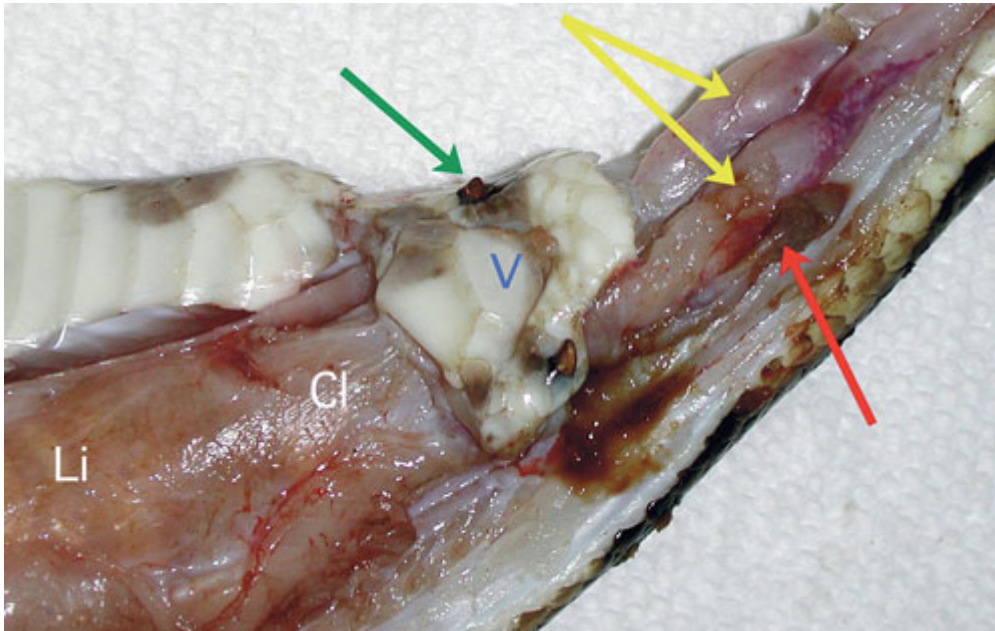
The junction between the esophagus and the stomach is clearly noted at a site approximately equal to three-fourths the length of the liver. Long and tubelike in shape, the stomach ends in a tight valve called the pylorus, where food is dumped into the first loop of the small intestine called the duodenum. The duodenum is found just after the end of the long, spindle-shaped, dark-brown liver.

In snakes the small intestine is usually straight, but some species may have short transverse loops. The small intestine terminates at the junction with the large intestine. A cecum, a small appendage between the small and large intestines, is present in some snake species. It is not known why some snakes have a cecum and others do not, but the appendage is generally found in herbivorous animals but not in carnivores.



Found in the fourth quarter of the snake are the adrenals (A), a testis (T) and the right kidney (K).

Like mammals, reptiles have relatively advanced (evolutionarily speaking) metanephric kidneys. They are situated in the rear part of a snake's body attached to the inner wall with the right kidney in front of the left. They are brown and consist of 25 to 30 lobes. These look like a stack of pennies that have been knocked over.



Found in the tail region are the large intestine (Li), cloaca (Cl), vent (V), vestigial pelvic limbs or spurs (green arrow), hemipenes (yellow arrows), and scent gland (red arrow).

The large intestine ends at the cloaca, a three-chambered structure with multiple functions. Feces is discharged from the large intestine directly into the cloaca's forward chamber, which is called the coprodeum. The middle chamber, called the urodeum, receives the urogenital (urinary and reproductive) ducts, which carry urine and either eggs (females) or sperm (males). The proctodeum, the posterior chamber, acts as a general collecting (mixing) area for digestive and excretory wastes. The male hemipenes open into the portion of this compartment nearest the tail, and both male and female snakes have scent glands that also open in this location.

Because snakes lack a bladder, the ureters leave the kidneys and open directly into the urodeum. Just before entering the urodeum, the snake's ureters widen, which acts as a urine storage organ.