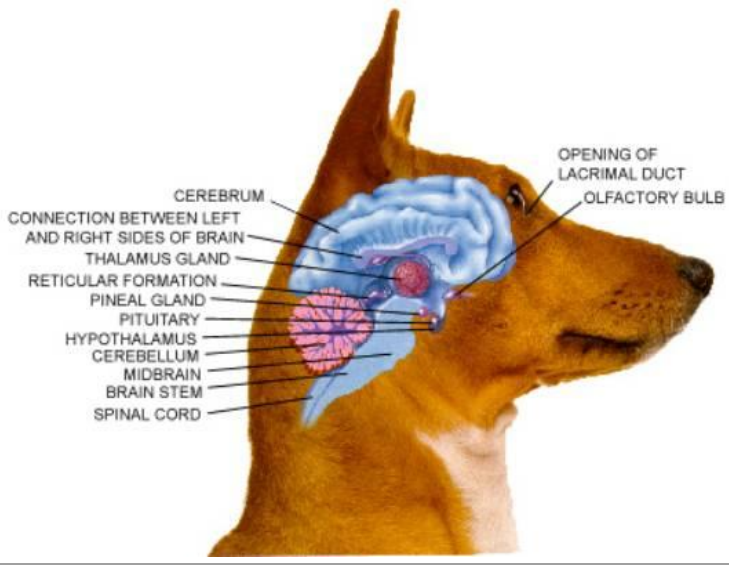
Canine Senses

The dog's brain synthesizes, interprets, and acts on all the information it receives from the senses. Although the brain of an average dog accounts for less than half a per cent of its body weight, it needs a great deal of nourishment to function properly and receives over 20% of the blood pumped out by the heart. Brain activity is, in part, predetermined by the "fixed wiring" of the dog's genes. Just as our brains are pre-wired to learn language, the dog's brain is pre-wired to learn to interpret scent, and a large part of the brain is devoted to this process. It is also able to interpret information from the other senses - touch, taste, hearing, and sight.

COORDINATION OF THE SENSES



Hearing: Highly mobile ears "capture" sounds and funnel them down to the ear drum. A dog might cock one ear to capture an initial sound, and then use both ears to catch the maximum number of sound waves. Experiments show that a dog can locate the source of a sound in six-hundredths of a second.

Vision: This dog's facial anatomy is similar to that of the wolf, with widely spaced eyes for good lateral vision. Focusing on an image directly in front is most efficient in breeds with frontally placed eyes.

Taste and Scent: Scenting and associated taste are both chemical senses. The average dog has over 200 million scent receptors in its nasal folds compared to a human's 5 million. It also has a vomeronasal organ above the roof of the mouth for capturing sex scent and transferring it to the brain.

The brain: All sensory information is converted in sensory nerves to chemical inessages for transmission and analysis by the brain. Some of these messages influence the pineal gland, in the base of the brain, which synchronizes all body rhythms.

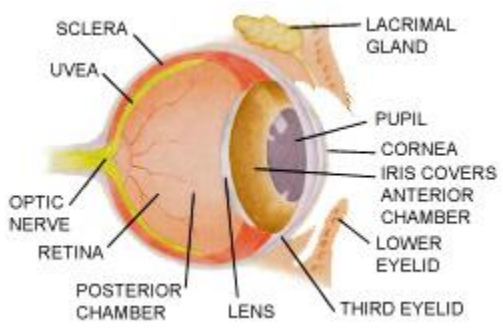
Touch: Touch receptors exist all over the body, but especially on the feet.

HOW THE BRAIN WORKS: The dog's brain stores information in two ways - it can either be conditioned or it can store what it learns. Both responses rely upon the individual dog's information-storage systems and are, in part, determined by genetics. The brain consists of billions of cells (neurons), each of which may have up to 10,000 connections with other cells. The cells chemically communicate with each other through neurotransmitters. The speed of these transmissions depends partly upon a fatty substance called myelin. In the dog's prime, messages are transmitted at great speed, but as the brain ages, messages move more slowly. Anatomically, the dog's brain is similar to the brains of most other mammals. The cerebrum controls learning, emotions, and behavior, the cerebellum controls the muscles, and the brain stem connects to the peripheral nervous system. Each sense feeds into the brain through its own special nerves. A network of cells throughout the brain (the limbic system) almost certainly integrates instinct and learning. The comfort between what a dog instinctively wants to do and what we teach it to do probably takes place in the brain's limbic system. Humans can override this system by giving rewards to the dog for obeying its owners rather than its "instincts".

HOW THE SENSES WORK: The dog's senses are similar in function to those of humans. Information from the senses feeds into the brain, where it triggers either a body response or hormonal activity. For example, if a dog steps on something and feels pain, it quickly steps back - a physical response. If it smells male or female dog scent, the pituitary gland in its brain activates and stimulates a hormonal response. SIGHT a dog's eye are flatter than a human's; although the dog can change the shape of its lenses, thereby adjusting focal length, it cannot do so as effectively as a human. A dog's eyes are more sensitive to light and movement than those of a human, but their resolving power is correspondingly less efficient. The consequence is that a human finds it easier to see a lost tennis ball lying in the grass than a dog does, whereas a dog finds it easier to see slight movement out of the corners of its eyes than a human does.

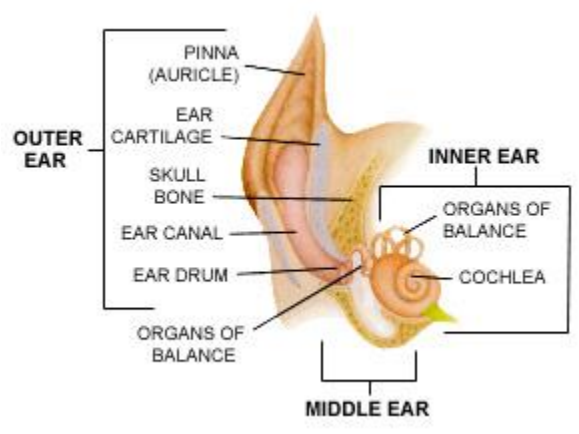
THE ANATOMY OF THE SENSES

The Eye



The eye consists of the corned, then an anterior fluid-filled chamber, followed by the three-part uvea - iris, ciliary body, and lens. Behind the lens is a large, fluid-filled posterior chamber, then the light sensitive retina which feeds information down the optic nerve to the brain. The third eyelid (nictitating membrane), which is hidden by the lower lid, sweeps the eye clean. The lachrymal gland produces tears to keep the cornea moist. Tears drain down the lachrymal duct into the nasal cavity. This can block, causing tears to overflow.

The Ears

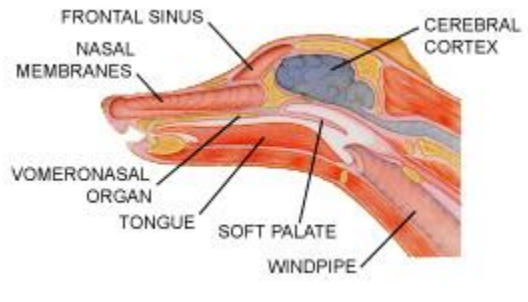


The cartilaginous outer ear (pinna) captures sound, and funnels it down the external ear canal to the ear drum (tympanic membrane). Ear -drum vibrations stimulate the organs of balance in the middle ear - the hammer, anvil, and stirrup (malleus, incus, and stapes), which amplify and transmit sound, while at the same time protecting the inner ear from excessive vibration. The cochlea (part of the inner ear) captures these sounds and converts them to chemical signals to the brain. Adjacent to the cochlea are the semicircular canals - the saccule and utricle - the organs of balance in the inner ear, which feed the brain with information on the alignment of the head.

The Taste Buds

Most taste receptors are on the anterior portion of the tongue and are sensitive to sweet, sour, bitter, and salty tastes. Other nerve endings act as touch or texture receptors. Although there are probably fewer than 2,000 taste receptors on the typical dog's tongue, as a "chemical" sense taste works in conjunction with the dog's infinitely more sensitive sense of smell. Odor initially attracts a dog to food, then taste and texture receptors take over.

The Scent Receptors



Moisture on the nose helps to capture scent, which is transmitted onto the nasal membranes, which cover the nose's wafer-thin turbinate bones. These bones have convoluted folds, ensuring that the tiniest amount of scent is captured within them. Sensory cells are closely packed along the nasal-membrane lining. Depending on the breed of the dog, smaller noses have less room for sensory cells. They convert scent to

chemical messages transmitted to the olfactory bulb region of the brain. Other scents are captured by the vomeronasal organ above the roof of the mouth, and transmitted to other parts of the brain.

Species	Number of Scent Receptors
Humans	5 million
Dachshund	125 million
Fox Terrier	147 million
Beagle	225 million
German Shepherd	225 million
Bloodhound	300 million

Though the size of this surface varies with the size and length of the dog's nose, even flat-nosed breeds can detect smells far better than people. The following table shows the number of scent receptors in people and several dog breeds. A dog's brain is also specialized for identifying scents. The percentage of the dog's brain that is devoted to analyzing smells through selective breeding, is actually 40 times larger than that of a human! It's been estimated that dogs can identify smells somewhere between 1,000 to 10,000 times better than nasally challenged humans can.

It's not hard to see why our ancient ancestors recruited dogs to their domestic staff. As well as being extremely intelligent, dogs are blessed with senses much more powerful than those of humans. In particular, their sense of smell is extraordinarily well-developed.

Dogs are capable of sniffing everything from drugs to electricity, underground gas pipelines to ovulating animals. Recent studies suggest that dogs may even be capable of using their super-sensitive snouts to detect human illnesses from epileptic fits to cancers.

Smell is the dog's dominant sense, so much so that a huge part of its brain is devoted to analyzing odors. Dogs have two giant olfactory bulbs attached to the brain which decode every smell they encounter. The bulbs weigh around 60 grams, four times as much as human olfactory bulbs. Given that a canine brain is one tenth of the size of a human one, that means the canine brain has forty times as much of its brain devoted to smell as we do.

Little wonder then that a dog's sense of smell is reckoned to be 100,000 times better than a human. In tests dogs have been able to pick up chemical solutions that form one or two parts in a trillion. That is the equivalent of smelling one bad apple in two billion barrels.

The source of the dog's exceptional ability to smell is indeed its wet snout. The moist leathery surface of the snout acts like velcro catching even the tiniest molecules of smells, then dissolving them so that the dog's internal, smell receptor cells can analyze them properly. To keep his nose wet a dog must produce a constant supply of mucus through its nasal cavities. Scientists reckon the average dog produces a pint of this mucus every day.

Dogs really can smell fear. If a dog goes into a room where a frightened dog has just left, he will appear anxious and agitated. This isn't, as many would claim, some kind of ESP type response. It's caused by a scent, an alarm pheromone, which is produced by the anal glands of frightened dogs.

Dogs can detect odors that are up to 40 feet underground. They have been used to detect leaky gas pipes. They can also smell insects embedded in the ground or in woodwork. In the United States dogs are used to sniff out termite infestations. Dogs can also pick up the faintest whiff of other creatures. In Guam, the US Department of Agriculture's Wildlife Service's use specially trained Jack Russell's to sniff out brown tree snakes in the loading bays of airplanes.

Dogs can smell human fingerprints that are a week old.

Dogs' noses are so sensitive that they can even smell electricity. While conducting an experiment, a researcher found that a dog could smell which of two compartments contained an electric current. He concluded this was because the charge resulted in the release of tiny amounts of ozone which the dog could detect.

Dogs can tell from the smell of a cow's urine whether it is in estrus, or heat. Farmers train them to do this so they know the best time to introduce a bull for breeding.

Dogs react in different ways to different smells. In tests, for example, it has been found that dogs relax when the aroma of lavender is fed into their environment. Chamomile also makes dogs calmer. Rosemary and peppermint, on the other hand, makes dogs more excited.

As far as dogs are concerned, all humans have a unique smell. They can pick people out according to body and other odors they project. Scientists think the only way a dog wouldn't be able to tell two people apart would be if they were identical twins on identical diets. The twins would also have to remain silent.

As a result of this, dogs can track human smells over long distances. Scientists think they can pick up on the difference in odors from different footprints to work out which direction their prey is headed. They can do this twenty minutes after a person has passed by even though the footprints are made a single second apart.

Scientists who tested four German Shepherds discovered they track footprints by dividing the job into three phases. During the first, search phase they move quickly, sniffing 10-20 times each breath. Once they have detected the smell they enter the deciding phase where they sniff at between two and five specific footprints. They do this for a longer period, slowing down as they do so. Finally, once the direction has been established, the tracking phase begins with the dog once more moving quickly.

Dogs can detect cancer in humans. Scientists think that simply by sniffing samples of human's breath, dogs can detect lung, breast and other cancers with an accuracy rate of between 88 and 97 percent. The accuracy rate of a multi-million-pound hospital scanner is between 85 and 90 per cent.

Dogs can also be trained to alert people with heart conditions they are about to suffer a seizure. Dogs can also anticipate in advance when a person is going to have an epileptic fit. A Canadian study found that dogs who lived with children prone to epileptic episodes behaved unusually in advance of the attacks. Some dogs would lick the child's face or act protectively. One dog even guided a young girl away from a set of stairs shortly before she had an attack. The dogs' warnings came as early as five hours before the first symptoms of the epileptic episode were visible. A separate study involving six dogs found that they could be trained to accurately warn owners who were about to suffer fits. Health authorities around the world are now training "seizure alert" or "seizure response" dogs, some of which can predict fits, and all of which will respond in an appropriate way when an owner does have a fit. Some will be trained to stay with and guard the owner, and some even to press a button on a phone which dials the emergency services.

It remains a mystery how they are able to pick up on epilepsy in this way. Some think they pick up on tiny behavioral or scent cues. Others are convinced it is a reaction to electrical activity in the body. But the fact that dogs also respond to psychological seizures, which are non-epileptic and don't display abnormal electrical activity, casts doubt on this.

Dogs' olfactory lobe, the part of the brain responsible for decoding scent messages is substantially larger than human olfactory lobe. Furthermore, they have an organ within their nose called the vomeronasal organ or VNO, which is used for detecting the pheromones, or chemical signals, from other animals and people. Using their uncanny sense of smell, dogs can identify others, determine who or what is and has been in a particular location, and even how those people or animals were feeling at that moment.

What's more, dogs can pick up smells in bombs and explosives with greater accuracy than human made chemical detectors, such as mass spectrometers. Other studies has actually shown that trained dogs can detect diabetes, seizure disorders and even certain types of human cancer with 80 to 100% accuracy. Understanding the canine sense of smell can help us to understand why a dog wants to take 10 minutes sniffing one spot of grass while on a walk and why dogs always insist on the greet-and-sniff with one another. It can also help us to appreciate just how phenomenal the canine sense of smell truly is.