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Rowan SOM

Venkataraman, Venkat
PhD

[INTERMEDIATE BRAIN BEE]

Contains the material needed to prepare for the regional NSF contests

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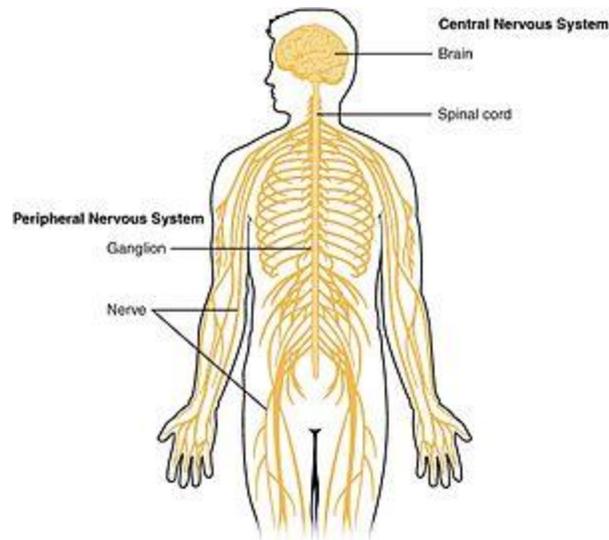
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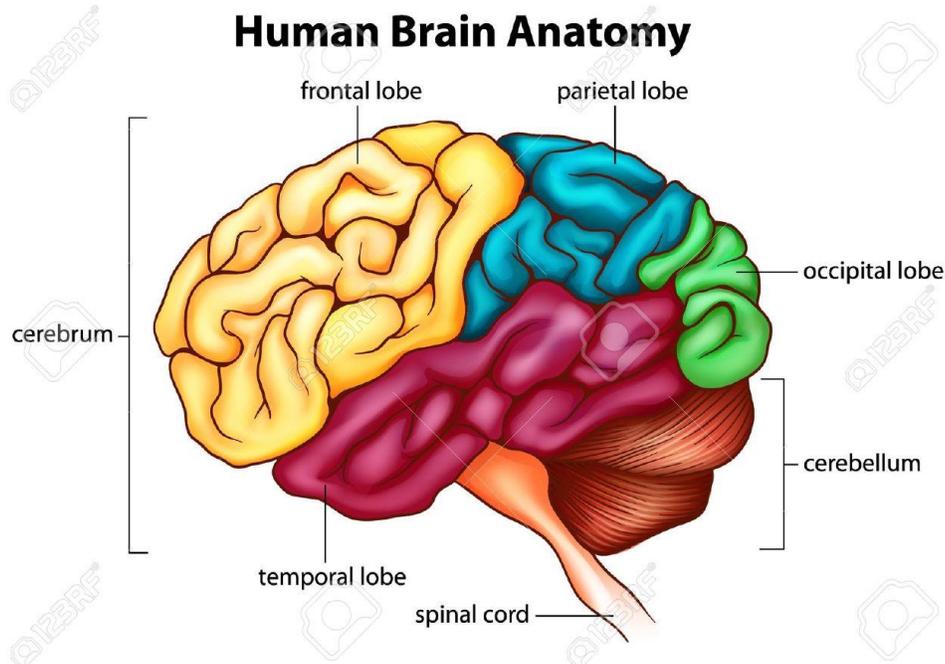
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NERVOUS SYSTEM



- The nervous system is a complex structure (made of neurons and supporting cells) that transmit signals around the body. It is in effect our body's electrical wiring.
- The nervous system of vertebrates (which includes humans and animals that have backbones and spinal columns) has two parts, the central nervous system (CNS) and the peripheral nervous system (PNS).
- The CNS includes the brain, spinal cord and retina of the eyes. Parts of the skeletal system protect the brain and the spinal cord: The brain is protected by the skull and the spinal cord, by the vertebrae.
- The PNS includes all other nervous system structures that sit outside the CNS but that help connect the CNS to areas of the body.
- Nerves are enclosed bundles of long fibers called axons that are parts of nerve cells. Neurons and glial cells have axons.
- Glial (or glia) cells are derived from the Greek word "glue". They are specialized cells that provide structure and support to neurons. They help hold neurons in place, supply nutrients to neurons, destroy germs, remove dead neurons, and direct axons of neurons.
- Some types of glial cells generate a substance called myelin that coat axons and work as electrical insulation to help them quickly and efficiently transmit signals.
- Neurons quickly and precisely send signals as electrochemical waves along axons to other cells. There are two types of neurons: sensory neurons and motor neurons.
- Sensory neurons change light, touch and sound into neural signals which are sent back to our CNS to help our body understand and react to its surroundings.
- Motor neurons transmit neural signals to activate muscles or glands.
- There are approximately 100 billion neurons in the human brain and 13.5 million neurons in the human spinal cord.
- The nervous system can transmit signals at speeds of 100 meters (328 feet) per second.
- The field of science that focuses on the study of the nervous system is called neuroscience. Neurology is the medical branch of study and treatment of the nervous system. Doctors and surgeons in this field are called neurologists and neurosurgeons.
- Nerves in our body can be vulnerable to both physical damage and damage through diseases. Damage to nerves can cause great pain, loss of feeling, or loss of muscle control.
- Physiatrists help rehabilitate patients with nervous system damage.

BRAIN



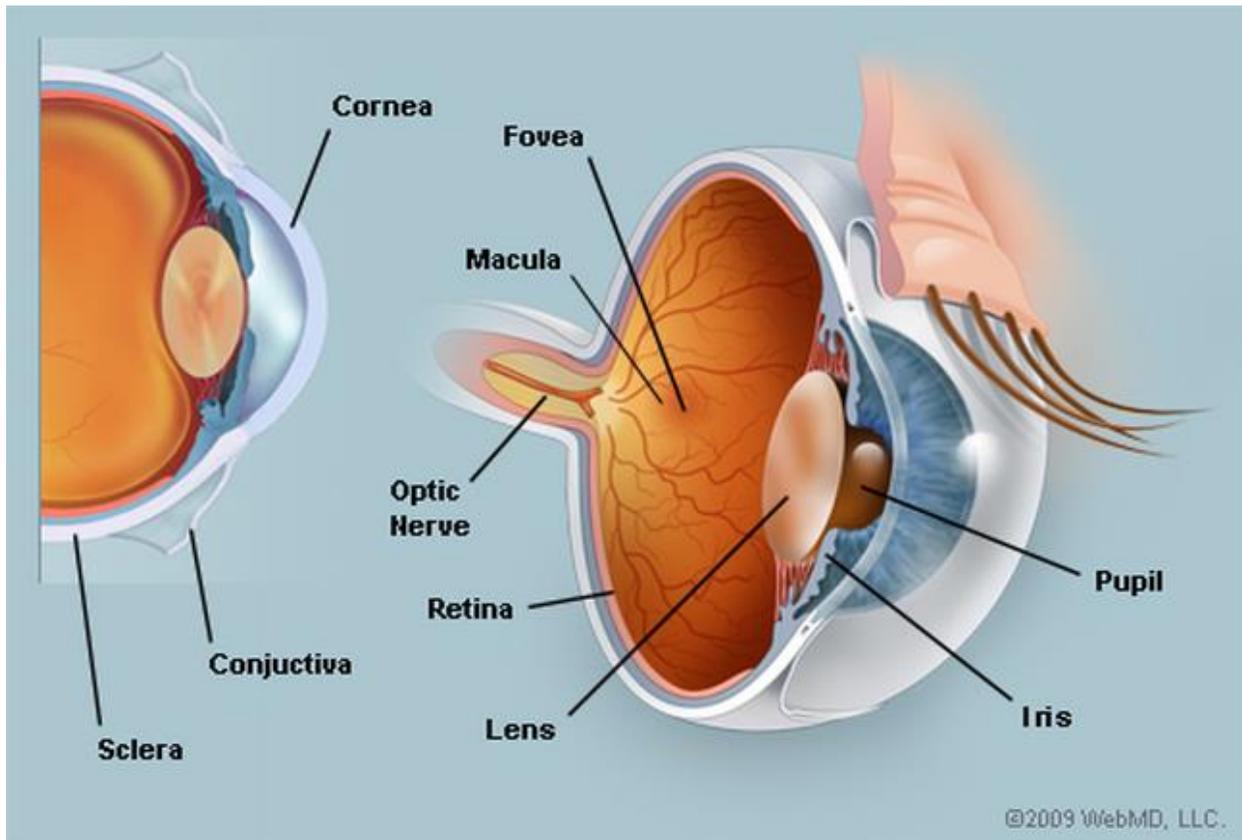
- The human brain is like a powerful computer that stores our memory and controls how we as humans think and react. It has evolved over time and features some incredibly intricate parts that scientists still struggle to understand.
- The brain is the center of the human nervous system, controlling our thoughts, movements, memories and decisions.
- With evolution, the human brain has become more and more complicated. Many of its interesting properties are still not well understood by scientists.
- The brain contains billions of nerve cells that send and receive information around the body.
- The human brain is over three times as big as the brain of other mammals that are of similar body size.
- Each side of the brain interacts largely with just one half of the body, but for reasons that are not yet fully understood, the interaction is with opposite sides, the right side of the brain interacts with the left side of the body, and vice versa.
- The largest part of the human brain is called the cerebrum. Other important parts include corpus callosum, cerebral cortex, thalamus, cerebellum, hypothalamus, hippocampus and brain stem.
- The human brain is protected by the skull (cranium), a protective casing made up of 22 bones that are joined together.
- The brain of an adult human weighs around 3 pounds (1.5 kg). Although it makes up just 2% of the body's weight, it uses around 20% of its energy.
- The brain is effectively floating in liquid (Cerebrospinal fluid) that acts as both a cushion to physical impact and a barrier to infections.
- Diseases of the brain include Alzheimer's disease, Parkinson's disease and multiple sclerosis. Diseases such as these can limit the normal function of the human brain.
- Most strokes result from a blood clot in the brain that blocks the local blood supply, which causes the damage or destruction of nearby brain tissue and a wide range of stroke symptoms.

SENSES



- Senses are a collection of sensory organs or cells in the body that respond to particular physical occurrences. Senses send information collected to various parts of the brain where the data is interpreted and an appropriate response signal returned.
- The exact number of senses humans have is disputed due to the various definitions of what a 'sense' is. However, it is widely agreed that there are five main human senses: sight, hearing, taste, touch and smell.
- **SIGHT/VISION** results from the ability of the eye to detect and focus on images of visible light with photoreceptors found in the retina of the eye. Electrical nerve impulses are generated for different colors, hues and brightness. The two types of photoreceptors are rods and cones. Rods are functional in dim light, while cones identify different colors in bright light.
- **HEARING** is a sense that detects the vibrations of sound. Mechanoreceptors in the inner ear, in the form of tiny bones and hair-like fibers, turn motion or sound waves from the air into electrical nerve pulses that the brain can then interpret.
- **TOUCH** is activated by neural receptors such as hair follicles found in the skin, but also pressure receptors on the tongue and throat.
- **TASTE** (of food) is detected by sensory cells called taste buds located on top of the tongue. There are five basic tastes: sweet, bitter, sour, salty and savoury.
- **SMELL**, like taste, is deemed to be a chemical sense. There are hundreds of olfactory receptors or sensory cells in our nasal passage, each of which will bind itself to a different molecular smell feature.

- Around 80% of what we think is taste is actually smell. Flavor, is a combination of taste and smell perception. Test this yourself by holding your nose closed the next time you eat something, can you taste it very well?
- Other perceived human senses are debatable but generally include, the ability to detect temperature, pain, balance and kinesthetic (which is the relative positions of our body parts - test this sense by closing your eyes and touching your nose with a finger).
- There are many internal body stimuli that may be perceived as senses too. For example, chemoreceptors for detecting salt and carbon dioxide concentrations in the blood and stretch receptors in the lungs which control our breathing rate.
- Compared to animals, humans have a quite weak sense of smell.
- Animals have differences in how their receptors sense the world around them. For example, dogs and sharks have a terrific sense of smell, while cats can see very well in dim light.
- Some animals have receptors in places that seem very unusual to us. Flies and butterflies, for example have taste organs on their feet, so they can taste anything they land on and catfish have taste organs across their entire bodies.
- Other animals have sense receptors we can only dream off. Some snakes have sensory organs that can detect infrared light, birds and bees can see ultraviolet light. Bats and dolphins use sonar to interpret their surroundings.
- Certain fish and rays can detect changes in nearby electrical fields and many bird species use the Earth's magnetic fields to determine the direction they are flying.

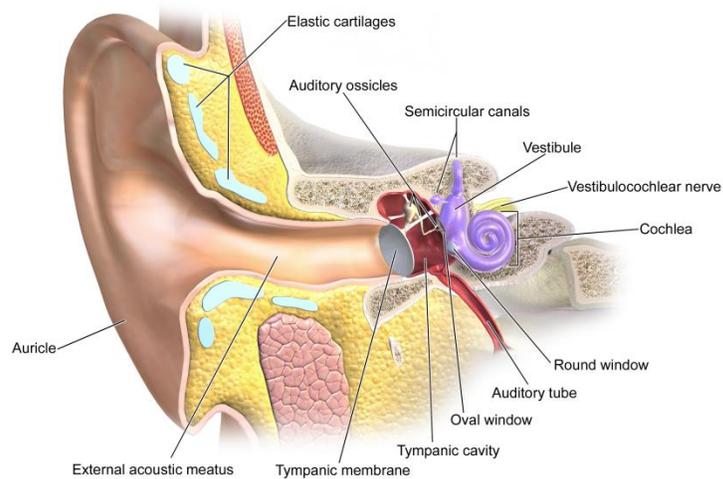
EYE

Eyes detect light and allow us to see.

- The information our eyes receive is sent to our brain along the optic nerve. This information is then processed by our brain and helps us make appropriate decisions. For example, if you can see an object flying in your direction then you will probably move quickly out of the way.
- Around 95% of animals have eyes. Some are very simple, just picking up light and dark conditions while others are more complex, allowing for the recognition of shapes, color and depth.
- Like humans, some animals have eyes placed close together that allow for improved depth perception, others have eyes spread further apart (often on opposite sides of their head, as in horses) to allow for a greater field of view and an early warning against potential predators.
- The light sensitive tissue lining the inner surface of your eye is known as the retina, acting similar to a film in a traditional camera.
- Cone cells in the retina detect color in bright light while rod cells detect low light contrasts.
- The part of the eye that allows us to focus on different things is known as the lens, it changes shapes so we can focus on objects at various distances.
- The cornea is the transparent covering of the iris and pupil; along with the lens, it refracts light so that images can be projected onto the retina.
- The central opening of the eye is known as the pupil. It changes size depending on the amount of light.
- The colored area around the pupil is called the iris. It controls the size of the pupil and can be colored brown, blue, green or other colors and shades depending on the person.

- Scientists believe that animal eyes evolved around 500 million years ago, beginning in simple form (perhaps just distinguishing light and dark) but giving a distinct advantage. This advantage led to eyes evolving quickly amongst animals (by evolutionary standards) in the struggle for existence.
- Throughout the animal kingdom there are many different types of eyes: the human eye is very different from the compound eye of a fly which is better at detecting fast movements.
- Human eyes contain a small blind spot where the optic nerve passes through the retina. Our brains use information from the other areas to fill in the vision gap; so it is rarely, if ever, noticed.
- Glasses and other protective equipment are often worn by humans to protect the eyes from UV rays or during other dangerous activities such as welding.
- Glasses and contact lenses are worn to correct common sight conditions such as short and long sightedness (myopia and hypermetropia).

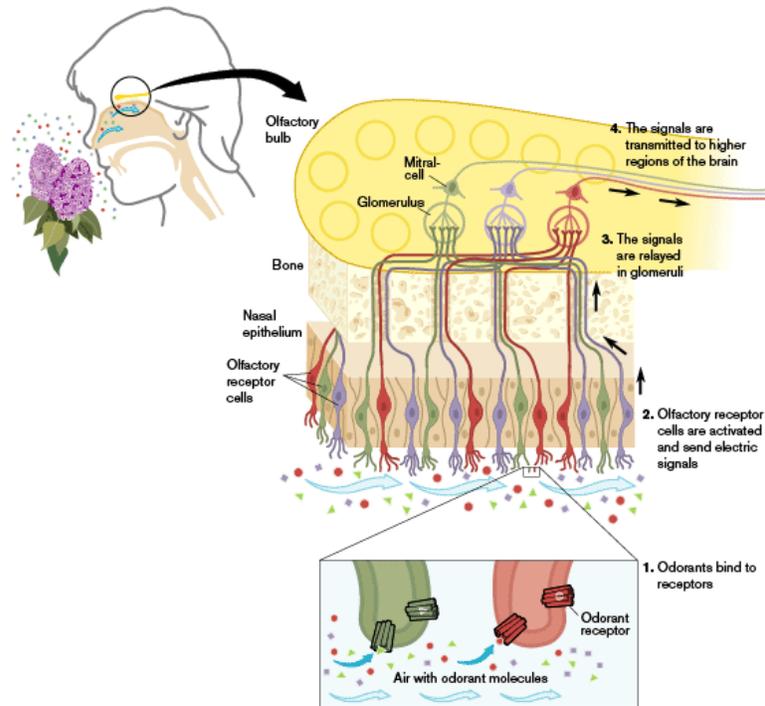
EAR



The Anatomy of the Ear

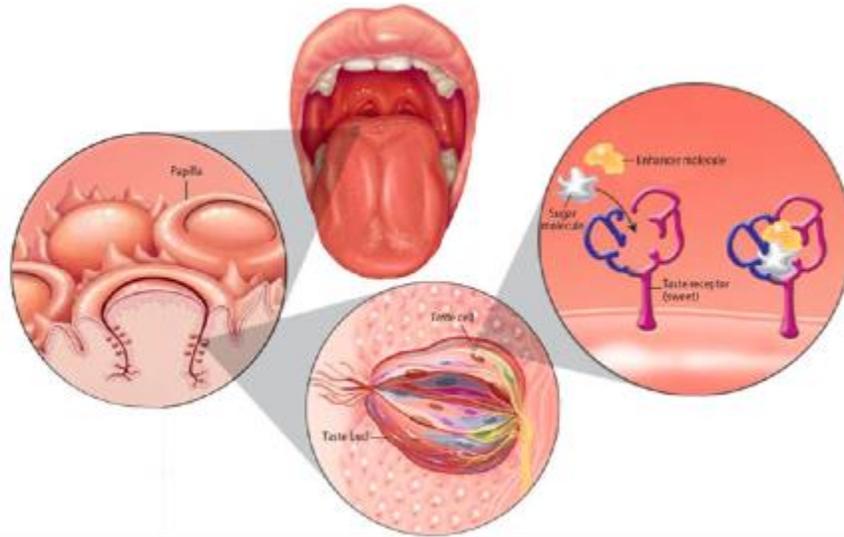
- Our ears help us detect sound. They convert sound waves into nerve impulses that are sent to the brain.
- While your ears pick up the sound, it is your brain that does the hard work of making sense of it all.
- There is much more to the ear than the part you can see on the outside of your head.
- The middle part of the ear (behind the ear drum) amplifies sound pressure. The middle ear also contains the Eustachian tube which helps equalize pressure and drain mucus.
- Ear infections are more common in children because of their developing immune systems and differences between their Eustachian tubes and those of adults.
- The inner ear is found inside the temporal bone, the hardest bone in the human body. It contains the spiral shaped hearing organ called the cochlea as well as the vestibule and semicircular canals which help with balance.
- Sounds waves are passed from air to liquid in the inner ear. The inner ear also contains tiny hair cells which react to sound waves, triggering chemicals that are sent to the brain as nerve impulses. Abnormalities in the inner ear of humans can cause deafness.
- Skin glands in the ear canal produce ear wax which helps protect the ear by lubricating it and cleaning it of dirt and dust.
- Excessive ear wax can impair hearing, especially if it is pressed hard against the eardrum.
- Ear wax normally comes out of your ear naturally so it's not a good idea to try and remove it yourself unless it is causing health problems (best to see your doctor first).

NOSE



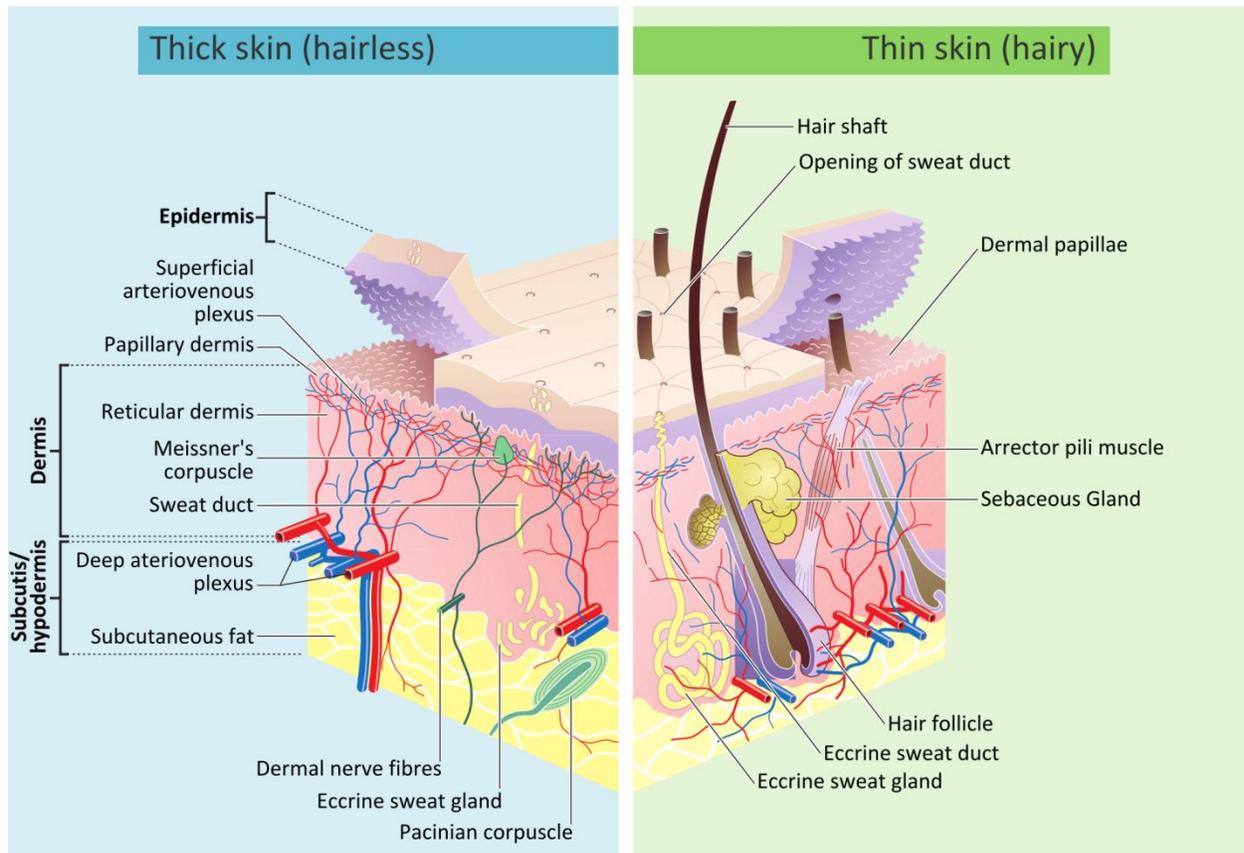
- The nose has special cells which help us smell.
- The technical term for sense of smell is 'olfaction'.
- Your nose can help detect dangerous chemicals in the air.
- The human nose can smell many different odors but is far less sensitive than other animals such as dogs.
- The human nose has 2 nostrils divided by the nasal septum. The nasal septum is made up mostly of cartilage, a tissue that is stiffer than muscle but more flexible than bone.
- Found at the roof of the nose, the ethmoid bone separates the nasal cavity and brain. The ethmoid bone is also one of the bones that make up the orbit of the human eye.
- The nasal cavity is a large space found inside the head, above and behind the nose.
- Air passing through the nasal cavity is warmed to match body temperature (or cooled if it is very hot).
- Dust and other particles are removed in the nasal cavity by short hairs. The floor of the nasal cavity is also the roof of the mouth.
- 'Anosmia' is the inability to smell.
- 'Dysosmia' is when things don't smell as they should.
- 'Hyperosmia' is having a very strong sense of smell.
- On average, men have larger noses than women.
- It is traditional for Maori people in New Zealand to press noses (hongi) as a greeting.
- Plastic surgery involving the nose is called 'rhinoplasty'.

TONGUE



- The tongue is a muscular structure attached to the floor of the mouth. It is the main sensory organ of taste.
- The upper surface of a tongue is covered with taste buds which contain taste receptors.
- The human tongue has on average 3,000 - 10,000 taste buds.
- The bumps we can see on the tongue are called papillae. Taste buds sit on top of these papillae but are not visible to the human eye.
- There are five elements of taste perception: salty, sour, bitter, sweet, and umami (or savory).
- Humans also use the tongue for speech where it helps with changes in sound.
- On average, women have shorter tongues than men.
- The human tongue is divided into two parts the anterior and the posterior.
- The anterior part of the tongue is the visible part at the front and is about two-thirds of the tongue's length.
- The posterior tongue area is closest to the throat, and roughly one-third of length.
- There are eight muscles in the human tongue. They can be classified as intrinsic or extrinsic.
- There are four intrinsic muscles which are not attached to any bone, they are the muscles that allow the tongue to change shape, such as point, roll, tuck etc.
- There are four extrinsic muscles which are attached to bone, they allow the tongue to change position, such as poke out, retract, side-to-side movement.
- The average length of the human tongue from the back to the tip is 10 cm (4 in).
- The blue whale has the largest tongue of all animals. Its tongue weighs around 2.7 metric tons (425 stone).
- Taste receptors cannot actually taste food until saliva has moistened it. We usually taste salty things first as salt dissolves quickly in moisture.
- Sticking your tongue out at people is seen as childish or rude in many countries, however, in Tibet it is considered a greeting.
- Dogs and cats often use their tongues to clean their fur and body. The very rough texture of their tongue allows them to remove oils and parasites.
- Have you ever wondered why a dog's tongue hangs out of its mouth after a lot of exercise? Well a dog's tongue increases in size as it exercises due to greater blood flow, moisture on the tongue works to cool this blood flow, cooling the dog.
- Some animal tongues are specially designed to catch prey. Chameleons, frogs, and anteaters have tongues that can extend out of their mouth and grab insects.

SKIN



Skin is the human body's largest organ (an organ is a group of tissues that work together to perform functions in your body. Others include your brain, heart and lungs).

- Your skin performs a range of different functions which include physically protecting your bones, muscles and internal organs, protecting your body from outside diseases, allowing you to feel and react to heat and cold and using blood to regulate your body heat.
- The layers of mammal skin include the epidermis, dermis and subcutis.
- The outer layer of your skin is the epidermis, it is found thickest on the palms of your hands and soles of your feet (around 1.5mm thick). (Think why!)
- The subcutis (or hypodermis) is the deepest layer of your skin. In addition to storing fat, it also contains blood vessels, hair follicle roots and nerves.
- If skin is severely damaged, it may try to heal by forming scar tissue. Scar tissue is not the same as normal skin tissue; it often appears discolored and lacks sweat glands and hair.
- The color of human skin depends on the amount of pigment melanin that the body produces. Small amounts of melanin result in light skin while large amounts result in dark skin.
- Areas that experience repeated friction or pressure can form tough, thick skin known as a callus. Common examples of calluses can be seen on the hands of tennis players and the fingertips of guitarists.
- A large amount of the dust in your home is actually dead skin!
- All mammals have some hair on their skin, even if it isn't always easy for you to see.
- Rhinoceroses are protected by thick skin which can be between 1.5cm and 5cm deep.

- Although polar bears have both white and transparent (see through) fur, their skin is actually black.
- Amphibians such as frogs have unique skin. Rather than drinking water, frogs actually soak it into their body through their skin. They also use their skin to absorb around half the air they need.
- Snakes have smooth, dry skin.
- A number of different sea creatures, such as sea lice and barnacles, attach themselves to the skin of whales, making it their home.
- Some fruits and vegetables are known to have 'skins', these include bananas, oranges, apples and potatoes.