Human Anatomy and Physiology | Unit 4 | HAP [For B Pharmacy]

The Human Body: Peripheral Nervous System and Sense Organs

This ebook provides a comprehensive overview of the Peripheral Nervous System and the five primary sense organs, detailing their structures, functions, and common disorders. Understanding these intricate systems is crucial to appreciating how our body interacts with the external world and maintains its internal environment.

Part 1: The Peripheral Nervous System

The nervous system is the body's control centre, and it is broadly divided into two main parts: the Central Nervous System (CNS) and the Peripheral Nervous System (PNS). The CNS consists of the brain and spinal cord, while the PNS comprises all the nervous tissue outside of these central structures.

1. Introduction to the Peripheral Nervous System

The **Peripheral Nervous System** acts as a vital communication network, connecting the CNS to the rest of the body. It includes the **cranial nerves**, **spinal nerves**, and their various roots and branches, as well as **peripheral nerves** and **neuromuscular junctions**. Essentially, the PNS is responsible for carrying signals to and from the brain and spinal cord, enabling us to sense our environment, move our muscles, and regulate involuntary bodily functions.

The PNS is functionally divided into two major parts:

- The **Autonomic Nervous System** (ANS), which controls involuntary functions.
- The **Somatic Nervous System**, which controls voluntary movements and transmits sensory information from the skin and muscles to the CNS.

2. Cranial Nerves and Their Pairs

Cranial nerves are a set of **twelve pairs of nerves** that emerge directly from the brain, primarily from the brainstem, rather than from the spinal cord. They are crucial for transmitting information between the brain and various parts of the head, neck, and torso. These nerves can be classified based on their primary function:

- **Sensory Nerves**: These nerves carry impulses from sensory receptors towards the brain, allowing us to perceive sensations.
- **Motor Nerves**: These nerves carry impulses away from the brain to muscles and glands, initiating movement or glandular secretions.
- **Mixed Nerves**: These nerves contain both sensory and motor fibres, performing both functions.

Here are the twelve pairs of cranial nerves and their main roles:

1. **Olfactory nerve**: Primarily responsible for the **sense of smell**.
2. **Optic nerve**: Transmits visual information, enabling **vision**.

3. **Oculomotor nerve**: Controls the movement of most of the **muscles of the eyeball**.
4. **Trochlear nerve**: Also supplies certain **muscles of the eyeball**, assisting in eye movement.
5. **Trigeminal nerve**: A mixed nerve with **sensory fibres** to the face and forehead, and **motor fibres** controlling the muscles involved in chewing (mastication).
6. **Abducent nerve**: Supplies another set of **muscles of the eyeball**, contributing to lateral eye movement.
7. **Facial nerve**: Primarily controls the **muscles of facial expression**.
8. **Auditory nerve (Vestibulocochlear nerve)**: This nerve has two distinct parts:
    - **Cochlear nerve**: Responsible for **hearing**.
    - **Vestibular nerve**: Concerned with **equilibrium and balance**.
9. **Glossopharyngeal nerve**: A mixed nerve with **sensory input** from the tongue and **motor control** over the pharyngeal muscles, important for swallowing.
10. **Vagus nerve**: Has widespread distribution, affecting the **pharynx, larynx, lungs, heart, stomach, and intestines**, playing a key role in parasympathetic regulation.
11. **Accessory nerve**: Divides into two parts; one part joins the vagus nerve and supplies the pharynx and larynx, while the other part supplies the **sternomastoid and trapezius muscles of the neck**, involved in head and shoulder movement.
12. **Hypoglossal nerve**: Primarily supplies the **muscles of the tongue**, essential for speech and swallowing.

Spinal Nerves and Nerve Plexuses

Spinal nerves are the body's major nerves, numbering **31 pairs**. They originate from the spinal cord and are responsible for controlling motor, sensory, and other functions throughout the body. These nerves can be affected by various medical conditions, leading to symptoms such as **pain, weakness, or decreased sensation**.

In certain regions of the spinal cord, several individual nerve trunks merge and intertwine to form complex networks known as **nerve plexuses**. These plexuses allow nerve fibres from different spinal nerves to be regrouped and distributed to specific body regions. The four main plexuses are:

- **Cervical plexus**: Formed by the first four cervical nerves. An important branch is the **phrenic nerve**, which supplies the **diaphragm**, essential for breathing.
- **Brachial plexus**: Formed by the lower four cervical nerves and the first thoracic nerve. Its crucial branches include the **circumflex nerve, musculocutaneous nerve, radial nerve, ulnar nerve, and median nerve**, which primarily supply the upper limbs.
- **Lumbar plexus**: Formed by the first four lumbar nerves. Its main branches are the **femoral nerve** and **obturator nerve**, serving the lower abdomen and thigh.
- **Sacral plexus**: Formed by the 4th and 5th lumbar nerves and the five sacral nerves. Its most significant branch is the **sciatic nerve**, which extends down the back of the leg.

Sensation and Sensory Path

Sensations are how our body perceives information from both its internal and external environments. They can be broadly categorised into two types:

1. **Special Sensation**: These are specific senses detected by specialised organs, such as the sensations of **smell, taste, sight, hearing, and balance**.
2. **General Sensation**: These are sensations that can be felt by **all parts of the body**, including touch, pressure, temperature, and pain.

The **sensory path** describes the route that sensory impulses take from the periphery to the brain:

1. **Peripheral nerves** initially carry both superficial and deep sensations towards the spinal cord.
2. These sensory fibres then enter the **posterior horn of the grey matter** in the spinal cord through the posterior nerve root.
3. From there, the fibres carrying deep and superficial sensations travel upwards through different pathways:
    - Superficial sensations travel upwards in the **anterior column** of the spinal cord.
    - Deep sensations travel upwards in the **posterior column** of the spinal cord.
4. Both sets of fibres cross over to the opposite side of the spinal cord at the level of the **medulla oblongata**.
5. Finally, these impulses are conveyed to the **sensory areas of the brain** via the brain stem, thalamus, and the white matter of the brain, where they are processed and interpreted.

Motor Path

The **motor path** is responsible for carrying signals from the brain to muscles, enabling voluntary movements. This pathway typically involves two main types of neurons:

1. The **upper motor neuron**, originating in the brain.
2. The **lower motor neuron**, which extends from the spinal cord to the muscle.

These neurons work in sequence, with the upper motor neuron relaying signals to the lower motor neuron, which then directly stimulates the muscle to contract, resulting in movement.

3. Autonomic Nervous System (ANS)

The **Autonomic Nervous System** is a vital component of the peripheral nervous system that **regulates involuntary physiologic processes**. These are functions that occur automatically without conscious thought, such as **heart rate, blood pressure, respiration, digestion, and sexual arousal**.

The ANS is divided into two anatomically and functionally distinct divisions, which often have opposing effects on target organs:

- **Sympathetic Nervous System**
- **Parasympathetic Nervous System**

a. Sympathetic Nervous System

The sympathetic nervous system is often referred to as the "fight or flight" system, preparing the body for stressful situations.

- **Sympathetic Chains**: A pair of sympathetic chains, composed of ganglia, are located on either side of the vertebral column. At the lower end, these two chains unite to form the **Ganglion impar**. Each sympathetic chain is further divided into cervical, thoracic, lumbar, and sacral parts.
- **Preganglionic Fibres**:
    - These fibres originate from the **lateral horn cells of the spinal cord**.
    - They pass through the anterior nerve roots of the spinal nerves.
    - They travel a short distance within the spinal nerve.
    - From the spinal nerve, they communicate with the ganglia of the sympathetic chain through structures called **White rami communicantes**.
- **Postganglionic Fibres**:

    - These fibres are formed from the ganglia of the sympathetic chain via **Grey rami communicantes**.
    - They enter spinal nerves at the same level and then extend to reach the specific organs they supply.
    - Some fibres may travel up to higher ganglia or down to lower ganglia within the sympathetic chain before reaching their target.
    - They exit a ganglion at an appropriate level through grey rami communicantes and enter spinal nerves.
- **Chemical Transmitters (Neurotransmitters)**:
    - The neurotransmitter released by the **preganglionic sympathetic nerve** at the ganglion is **Acetylcholine**.
    - The neurotransmitter released at the **postganglionic sympathetic nerve ending** is **Noradrenaline**.
- **Adrenergic Receptors**: The receptors located at the postganglionic sympathetic nerve endings, which bind Noradrenaline, are called **Adrenergic receptors**. They are classified as:
    - **Alpha receptors**: Their action is generally **excitatory**, except in the intestine where it is inhibitory.
    - **Beta receptors**: Their action is generally **inhibitory**, except in the heart where it is excitatory.

The sympathetic system prepares the body for action by dilating pupils, inhibiting salivation, relaxing bronchi, accelerating heart rate, inhibiting peristalsis and secretion, stimulating glucose production and release, secreting adrenaline and noradrenaline, inhibiting bladder contraction, and stimulating orgasm.

b. Parasympathetic Nervous System

The parasympathetic nervous system is often called the "rest and digest" system, responsible for conserving energy and maintaining routine bodily functions.

- **Preganglionic Fibres**:
    - These fibres arise from cells located in the **midbrain, medulla, and sacral portion of the spinal cord**.
    - Specifically, at the sacral portion of the spinal cord, they originate from the anterior column of the 2nd, 3rd, and 4th lumbar segments.
    - They then pass through the anterior roots of the corresponding spinal nerves.
- **Postganglionic Fibres**: These fibres emerge from the ganglia and then reach the specific structures or organs that they innervate.
- **Neurotransmitters**:
    - The neurotransmitter released by the **preganglionic parasympathetic nerve** at the ganglion is **Acetylcholine**.
    - The neurotransmitter released at the **postganglionic parasympathetic nerve ending** is **Acetylcholine** as well.
- **Cholinergic Receptors**: The receptors for Acetylcholine are known as **Cholinergic receptors**. They are found in two main locations:
    - At both sympathetic and parasympathetic ganglia, these receptors are called **Nicotinic receptors**.
    - At postganglionic parasympathetic nerve endings, these receptors are called **Muscarinic receptors**.

The parasympathetic system promotes bodily functions at rest by constricting pupils, stimulating saliva flow, constricting bronchi, slowing heart rate, stimulating peristalsis and secretion, stimulating bile release, and contracting the bladder.

Part 2: Sense Organs

Sense organs are specialised parts of the body that respond to external stimuli by converting them into electrical impulses that are conveyed to the sensory nervous system. These impulses are then interpreted by the brain, allowing us to perceive our environment. There are five primary sense organs: **eyes, ears, skin, nose, and tongue**.

1. The Eye

The **eye** is the sensory organ of **vision**, located within the orbital cavity of the skull. It is globular in shape and approximately 2.5 cm in diameter.

Main Functions of the Eye:

- **Light Detection**: The eye detects light reflected from objects.
- **Night Vision**: In low light conditions, fewer items reflect light, making it harder to see in darkness.
- **Focus**: The eye acts like a camera, using a lens to focus light.
- **Depth Perception**: Allows us to judge the distance of objects.
- **Balance**: Although primarily a function of the ear, visual input contributes to maintaining balance.

Structures of the Eye:

The eye includes several protective and functional structures:

- **1. Eye Brows**: These are two arches of **thick skin** located over the eyes, containing thick hairs. Their main function is to **prevent sweat, dust, or other foreign particles** from entering the eyes.
- **2. Eyelids**: These are two **movable folds of tissue** situated above and below the front of each eye. When you blink, your eyelids spread moisture over your eyes, keeping them lubricated and clean.
- **3. Lacrimal Apparatus**: This system is responsible for the **production of tears**. It consists of lacrimal glands and their duct system. Tears have an **antibacterial function** and **lubricate the front part of the eye**.
- **4. Extrinsic Muscles of the Eye**: Six muscles are responsible for moving the eyeball:
    - **Superior rectus**: Moves the eye **upwards**.
    - **Inferior rectus**: Moves the eye **downwards**.
    - **Medial rectus**: Moves the eye **inwards**.
    - **Lateral rectus**: Moves the eye **outwards**.
    - **Inferior oblique**: Moves the eye **up and outwards**.
    - **Superior oblique**: Moves the eye **down and outwards**.

Structure of the Eyeball:

The eyeball is almost **spherical in shape** and is located in the anterior part of the orbital cavity. It contains:

- **1. Three Coats**: These are the layers that form the wall of the eyeball:

    - **Outer Fibrous Coat**:
        - **Sclera**: Forms the **white of the eye**. It has a rich blood supply, and the muscles of the eyeball are attached to its surface. The sclera is covered by a thin mucous membrane called the **conjunctiva**.
        - **Cornea**: This transparent structure **transmits light** into the eye. It does not contain blood vessels but is richly supplied by sensory nerves to carry **pain sensation**.
    - **Middle Vascular Coat (Uvea)**:
        - **Choroid**: A thin layer of tissue that forms part of the middle layer of the eye wall, located between the sclera and the retina. It is highly vascular.
        - **Ciliary Body**: Contains **ciliary muscle** and secretory epithelial cells that produce **aqueous humour**.
        - **Iris**: This is the anterior continuation of the ciliary body. It is a pigmented, muscular curtain at the front of the eye, between the cornea and the lens. It has an opening in its centre called the **pupil**.
    - **Inner Nervous Coat**:
        - **Retina**: A layer of tissue at the back of your eye that **senses light and sends images to your brain**. It is the photosensitive layer of the eye, containing specialized receptors.
- **2. Light Transmitting Structures**: These transparent components allow light to pass through and be focused on the retina:
    - **Aqueous Humour**: A transparent, water-like fluid similar to plasma, but with low protein concentrations. It is present in both the anterior and posterior chambers of the eye and is secreted by the ciliary body.
    - **Lens**: A nearly transparent, **biconvex structure** suspended behind the iris. Its primary function is to **focus light rays** precisely onto the retina.
    - **Vitreous Humour**: A clear, gel-like substance that fills the space behind the lens and in front of the retina at the back of the eye, helping maintain the eye's shape.

Mechanism of Vision:

Vision is a complex process involving several steps:

1. Light **enters the eye** through the **cornea**.
2. The **iris** and the **pupil** regulate the **amount of light** entering the eye by constricting or dilating.
3. The image is then **focused** by the **lens** onto the **retina**.
4. The pigmented choroid darkens the interior of the eye, preventing light scatter.
5. The focused image **stimulates the receptors** present in the **rod and cone cells of the retina**.
6. These impulses are then carried away from the eye through the **optic nerve**.
7. The optic nerves from both eyes cross at a point called the **optic chiasma**.
8. From the optic chiasma, the impulses travel via the **optic tract** to the **visual cortex** located in the occipital lobe of the brain, where the image is interpreted.

Diseases of the Eye:

Many conditions can affect vision and eye health:

1. **Myopia (short sight)**: Distant objects cannot be seen clearly.
2. **Hypermetropia (long sight)**: Near objects cannot be seen clearly.
3. **Presbyopia**: A defect in accommodation that occurs in old age due to a **loss of elasticity of the lens**.
4. **Glaucoma**: If left untreated, it can lead to blindness due to **retinal damage**.

5. **Colour blindness**: A defect in the **retina** where the patient cannot perceive one or more colours.
6. **Night blindness (Nyctalopia)**: The inability to see in dim light, often due to a **deficiency of vitamin A**.
7. **Cataract**: Characterised by an **opacity of the lens**.
8. **Diplopia**: Also known as **double vision**.
9. **Xerophthalmia**: Refers to **dryness of the eyes**.
10. **Keratomalacia**: The cornea becomes **soft** and may eventually **become perforated**.

2. The Ear

The **ear** is a complex sensory organ responsible for both **hearing and equilibrium (balance)**. It is anatomically divided into three main parts: the external ear, middle ear, and internal ear.

External Ear:

This is the only part of the ear located outside the skull. It consists of:

1. **Pinna or Auricle**: This is the visible, funnel-shaped outer part of the ear, made of elastic fibrocartilage. It helps to **collect sound waves** from the environment.
2. **External Auditory Meatus**: A small channel lined with skin and wax-secreting glands. It **conveys the vibrations of sound** collected by the pinna to the tympanic membrane.

Middle Ear (Tympanic Cavity):

The middle ear is a **small cavity** located within the temporal bone. It contains several important structures:

1. **Tympanic Membrane or Ear Drum**: Forms the lateral wall of the middle ear and vibrates in response to sound waves.
2. **Tensor Tympani Muscle and Stapedius Muscle**: Small muscles that help regulate the tension of the tympanic membrane and the movement of the ossicles.
3. **Two Foramina**: These are openings in the inner or medial wall: the **Fenestra Ovalis (oval window)** and **Fenestra Rotundum (round window)**.
4. **Eustachian Tube**: Connects the middle ear anteriorly with the nasopharynx, helping to **equalise pressure** across the tympanic membrane.
5. **Auditus**: A narrow channel connecting the middle ear posteriorly with the mastoid antrum.
6. **Auditory Ossicles**: Three tiny bones arranged across the middle ear. These are the **Malleus (hammer), Incus (anvil), and Stapes (stirrup)**. They transmit sound vibrations from the tympanic membrane to the inner ear.

Inner Ear (Labyrinth):

Also known as the **labyrinth**, the inner ear is the most complex part, containing the sensory organs for **hearing and equilibrium**. The **bony labyrinth**, a cavity in the temporal bone, is divided into three sections:

- **Vestibule**: This is the central part of the bony labyrinth. It contains the **Utricle and Saccule**, which are parts of the membranous labyrinth and are involved in sensing linear acceleration and head position.
- **Cochlea**: A **spiral canal** resembling the shell of a snail. It contains:
    - **Modiolus**: A central column of spongy bone around which the spiral canal twists.

    - **Basilar Membrane**: A membranous septum that divides the cochlea into two parts: the upper part (Scala Vestibuli) and the lower part (Scala Media).
    - **Organ of Corti**: The actual **auditory receptor** that rests on the basilar membrane, containing hair cells that convert sound vibrations into nerve impulses.
- **Semicircular Canals**: Each ear has **three semicircular canals** (posterior, superior, and lateral). These canals are crucial for sensing **rotational movements of the head** and maintaining dynamic equilibrium.

Mechanism of Hearing:

The process of hearing involves a series of transformations of sound waves into neural signals:

1. **Sound waves** in the air are **collected by the pinna**.
2. The **external auditory meatus** directs these waves to the **tympanic membrane**, causing it to **vibrate**.
3. These vibrations are then **transmitted** by the **Malleus, Incus, and Stapes** to the membrane covering the fenestra ovalis (oval window).
4. From the inner surface of this membrane, the **vibrations are transmitted to the Organ of Corti** within the cochlea via the perilymph and endolymph fluids.
5. The Organ of Corti converts these mechanical vibrations into electrical impulses, which are then carried to the **brain stem** through the cochlear portion of the **8th cranial nerve**.
6. Finally, these fibres are relayed to the **auditory centre of the brain**, located in the temporal lobe of the opposite side, where sound is perceived and interpreted.

Mechanism of Equilibrium:

The ear also plays a crucial role in maintaining balance:

- Movement of the **endolymph fluid** within the semicircular canals and vestibule **stimulates the nerve endings in the ampullae** (enlargements at the base of the semicircular canals).
- These impulses are then **carried to the brain** through the vestibular portion of the **8th cranial nerve**.
- The brain processes these impulses, producing sensations that make us **conscious of the position of the head**.
- If the position of the head is **disoriented**, the brain can send signals to adjust the body to **maintain balance and equilibrium**.

Common Diseases of the Ear:

Various conditions can affect the ear, leading to hearing loss or balance issues:

1. **Meniere's Syndrome**: Characterised by **hearing loss** due to pathological distension of the membranous labyrinth, often accompanied by vertigo and tinnitus.
2. **Eustachitis**: Occurs due to **inflammation of the Eustachian tube**, which connects the middle ear to the nasopharynx.
3. **Tympanitis**: Refers to **inflammation of the ear drum**.
4. **Otalgia**: Simply means **pain in the ear**.
5. **Otitis Media**: An **acute infection in the middle ear**, common in children.
6. **Presbycusis**: The **loss of hearing that gradually occurs in most individuals as they grow older**. Approximately 30-35 percent of adults aged 65 and older experience some degree of hearing loss.

7. **Benign Paroxysmal Positional Vertigo (BPPV)**: One of the most common causes of vertigo, characterised by the sudden sensation that you're **spinning or that the inside of your head is spinning**, usually triggered by specific head movements.
8. **Otosclerosis**: Involves the hardening of the ear, resulting from the formation of **abnormal spongy bone** growth around the **stapes** in the middle ear. This new bone growth makes the stapes immobile, which **prevents the transmission of sound vibrations into the inner ear**, leading to **conductive hearing loss**. Otosclerosis typically affects both ears.

3. The Skin

The **skin** is the **largest organ in the body**. It forms a **protective covering** for the body, acting as a barrier in contact with the external environment. Beyond protection, the skin plays a crucial role in the **regulation of body temperature**.

The skin is composed of two primary layers:

- The **outer layer** is called the **epidermis**.
- The **inner layer** is called the **dermis**.

Structure of the Skin:

- **Epidermis**: This is the **outermost layer of the skin**, composed of stratified squamous epithelium. It is further divided into five distinct layers:

    1. **Stratum Corneum**: The most **superficial layer**. Its cells contain **keratin** and **lack nuclei**. This layer provides a tough, protective barrier.
    2. **Stratum Lucidum**: A thin, more or less transparent, **glistening layer** found primarily in thick skin (palms and soles). The cells in this layer contain cytoplasm.
    3. **Stratum Granulosum**: This layer contains **spindle-shaped cells**. Both **cytoplasm and nucleus** are present in these cells.
    4. **Stratum Spinosum**: It contains **polyhedral cells** (many-sided).
    5. **Stratum Germinativum (Basale)**: This is the deepest layer, composed of a single layer of **columnar or cuboidal cells**. This layer is directly **connected to the dermis** and contains **melanin pigments**, which determine skin colour.
- **Dermis**: Located beneath the epidermis, the dermis is composed of **connective tissue** and is **highly vascular** (rich in blood vessels). It is made up of **fibroelastic tissue**, which provides the skin's **texture, strength, and elasticity**.

    The dermis also contains various glands and structures:

    1. **Sebaceous Gland**: These are **flask-shaped glands** that secrete an oil-like material called **sebum**. They have a duct that opens into a hair follicle. Sebum is essential as it **prevents excess evaporation of water from the skin and prevents drying of skin**. Sebaceous glands are present in most parts of the body except for the skin of the **palms and soles of the feet**.
    2. **Sweat Gland**: There are two types:
        - **Eccrine glands**: Present all over the body, secreting **watery sweat** for cooling.
        - **Apocrine glands**: Located in the axilla, female genitalia, and around the nipples, secreting **milky sweat**.
    3. **Ceruminous Gland**: These glands secrete **wax** into the external ear canal.

4. **Hair Roots and Erector Pili Muscles**: The contraction of these small muscles produces the **straightening of the hair** (causing "goosebumps").

Functions of Skin:

The skin performs numerous vital functions:

1. **Protection**: It **protects the body against injury** and **bacterial invasion**.
2. **Regulation of Body Temperature**: Plays a critical role in maintaining a stable internal body temperature.
3. **Sensation**: Serves as a medium for **receiving sensations** such as touch, pressure, and temperature.
4. **Excretion**: Excretes substances like **sodium chloride and metabolites like urea**.
5. **Water and Electrolyte Balance**: Helps maintain the body's water and electrolyte balance.
6. **Vitamin D Synthesis**: Synthesises **vitamin D** from ergosterol upon exposure to **ultraviolet rays of sunlight**.
7. **Melanin Synthesis**: Synthesises **melanin** from tyrosine, providing protection against UV radiation.
8. **Secretion**: Secretes **sweat and sebum**, which keep the skin soft and moisturised.
9. **Storage**: Stores fat, water, chlorides, and sugar.

Regulation of Body Temperature:

The normal body temperature is typically **98.4°C (37°F)**. This temperature is maintained by a delicate balance between **heat production and heat loss**. Body temperature is primarily controlled by the **heat-regulating centre present in the hypothalamus** of the brain.

- **Heat Production**: The body generates heat through several mechanisms:

    1. Increased **activity of muscles** during severe exercise.
    2. Increased activity of the **liver and other glands** in the body.
    3. Increased **intake of food** (especially proteins).
    4. Increased **metabolism**, such as the oxidation of foodstuffs and combustion of fat.
    5. Endocrine secretions like **adrenaline and noradrenaline** can also increase heat production.
- **Heat Loss**: The body loses heat to the environment through various processes:

    1. **Radiation**: Body heat is lost to the surrounding air without direct contact.
    2. **Conduction**: Heat is lost through direct contact with cooler objects, such as clothing or bedding.
    3. **Convection**: Hot air around the body moves upwards and is replaced by cooler air, leading to heat loss.
    4. **Sweating**: The evaporation of sweat from the skin makes the body cool, leading to heat loss.
    5. **Evaporation**: Water evaporation from the skin, mucous membranes, and respiratory passages also contributes to body heat loss.

Disorders of the Skin (Sense Organ Related):

Many disorders can affect the skin, impacting its protective and sensory functions:

- **Acne**: Characterised by **blocked skin follicles** that lead to an accumulation of oil, bacteria, and dead skin cells in pores.
- **Alopecia Areata**: An autoimmune condition resulting in **losing hair in small patches**.
- **Atopic Dermatitis (Eczema)**: Causes **dry, itchy skin** that can lead to swelling, cracking, or scaliness.
- **Psoriasis**: A chronic skin condition causing **scaly skin that may swell or feel hot**.
- **Raynaud's Phenomenon**: Causes periodic **reduced blood flow to the fingers, toes, or other body parts**, leading to numbness or skin colour changes.
- **Rosacea**: A common skin condition causing **thick skin and pimples**, usually on the face.
- **Skin Cancer**: Involves the **uncontrolled growth of abnormal skin cells**.
- **Vitiligo**: A condition where **patches of skin lose pigment**, resulting in lighter areas.

4. The Nose

The **nose** is an integral part of your **respiratory system** and a key **sense organ**. It allows air to enter your body, filtering out debris, warming, and moistening the air before it reaches the lungs. Your nose also provides you with the **sense of smell** and plays a role in shaping your appearance. The sensory nerves responsible for smell are known as the **olfactory nerves**.

Parts of the Nose:

- **Bone**: The **hard bridge** at the top of your nose is made of bone.
- **Hair and Cilia**: Inside your nose, hair and cilia (tiny hair-like structures) **trap dirt and particles**, preventing them from entering the respiratory system.
- **Lateral Walls (Outer Walls)**: The outer walls of your nose are made of cartilage and are covered in skin.
- **Nasal Cavities**: Your nose contains **two nasal cavities**, which are hollow spaces where air flows in and out.
- **Nerve Cells**: These specialized cells within the nasal cavities **communicate with your brain** to provide the sense of smell.
- **Nostrils (Nares)**: These are the **openings to the nasal cavities**.
- **Septum**: The septum is a wall made of **bone and firm cartilage** that divides the two nasal cavities.
- **Sinuses**: You have **four pairs of sinuses**, which are air-filled spaces connected to the nasal cavities.
- **Turbinates (Conchae)**: There are **three pairs of turbinates** (superior, middle, inferior) located along the sides of both nasal cavities, which help to warm and humidify inhaled air.

Sensation of Smell:

The process of smelling is intricate:

1. The receptors for smell are specialised **olfactory cells**.
2. These cells are located in the **mucous membrane** of the upper part of the nasal cavity.
3. The ends of the **olfactory rods** (dendrites of olfactory cells) collect to form the **olfactory nerve**.
4. This nerve passes through the roof of the nose and ends in the **olfactory bulb**, a structure in the brain that processes smell information.
5. The sensations are then carried through the **olfactory tract** to the **olfactory area** in the temporal lobe of the cerebral cortex.
6. The **perception of smell** occurs in this specific brain area.

Functions of the Nose:

The nose performs several critical functions:

- **Sense of Smell**: Its primary sensory function.
- **Air Filtration**: Hair in the nose **cleans the air** by trapping foreign particles.
- **Air Conditioning**: The nose **conditions inhaled air**, warming it and making it **more humid** before it reaches the lungs.
- **Protection of Lower Airway**: Helps protect the more delicate lower respiratory tract.
- **Ventilation & Drainage of PNS (Paranasal Sinuses)**: Facilitates air exchange and drainage of the paranasal sinuses.
- **Olfaction (Increased on Sniffing)**: Sniffing increases air flow over the olfactory receptors, enhancing the sense of smell.
- **Nasal Resistance**: Provides resistance to airflow, which is important for proper lung function.
- **Vocal Resonance**: Contributes to the resonance of the voice.
- **Nasal Reflexes**: Involved in various reflexes like sneezing.

Disorders of the Nose:

The nose can be affected by a range of conditions, impacting breathing and smell:

- **Allergic Rhinitis**: An **inflammation of the membranes lining the nose**, typically caused by allergens.
- **Cerebral Spinal Fluid Leaks**: A serious condition where cerebrospinal fluid leaks from the brain or spinal cord, potentially through the nose.
- **Chronic Sinusitis with Polyps**: An **inflammation of the sinuses that lasts more than 12 weeks** and is associated with **nasal polyps** (non-cancerous growths).
- **Chronic Sinusitis without Polyps**: Similar inflammation of the sinuses, but without the presence of polyps.
- **Fungal Sinusitis**: Includes allergic fungal sinusitis, fungal ball, acute fungal sinusitis, or **chronic invasive fungal sinusitis**.
- **Inverting Papilloma**: **Benign tumours that form inside the nose**, but can sometimes become malignant.
- **Meningoencephalocele**: A condition where the lining of the brain and/or brain tissue protrude through an **opening in the skull**, often near the nose.
- **Nasal Fractures**: Breaks in the bones of the nose.
- **Nasal Masses and Nasal Tumours**: Abnormal growths within the nasal cavity.

5. The Tongue

The **tongue** is a highly **muscular organ** located in the mouth. It plays a crucial role in the process of **mastication (chewing) of food** and is essential in the act of **swallowing**.

Location and Description:

The tongue is a **mobile organ**, situated within the mouth. Its central surface is connected to the floor of the mouth by a fold of mucous membrane called the **frenulum linguae**. The anterior two-thirds of the tongue's surface is covered with small projections called **taste papillae**. There are three main types of taste papillae:

- **Circumvallate papillae**: Large, round papillae found at the back of the tongue.
- **Fungiform papillae**: Mushroom-shaped papillae scattered over the tongue's surface.

- **Filiform papillae**: Hair-like papillae that cover most of the tongue, providing texture and friction but no taste buds.

Parts of the Tongue:

1. **Tip**: This highly agile part of the tongue houses taste buds primarily for the **sweet sensation**.
2. **Root**: This part attaches the tongue to the floor of the mouth cavity.
3. **Dorsum**: This refers to the **curved upper surface** of the tongue, facing towards the back.
4. **Ventral Surface**: The surface located **underneath the tongue**.
5. **Borders**: These are the **sides of the tongue**.

Functions of the Tongue:

The tongue performs several essential functions:

1. **Taste**: It is the primary **organ of taste**, allowing us to perceive sweet, salt, bitter, and sour flavours.
2. **Mastication**: Helps in **chewing food** by manipulating it within the mouth.
3. **Swallowing**: Crucial for initiating and facilitating the act of swallowing.
4. **Cleaning the Lip**: Helps to keep the inside of the lips clean.
5. **Speech**: Essential for articulation and the formation of speech sounds.

Sensation of Taste:

The tongue is primarily concerned with **taste sensation**.

- On the dorsum (upper surface) of the anterior two-thirds of the tongue, there are **taste papillae**, which contain specialized sensory receptors called **taste buds**.
- **Taste buds** are the end organs of taste and are responsible for detecting different flavours. While all taste buds can detect all tastes, there are general areas of heightened sensitivity:
    - **Sweet** is primarily perceived at the **tip of the tongue**.
    - **Salt** is sensed at the **back of the tongue**.
    - **Sour** is detected at the **back edge of the tongue**.
    - **Bitter** is perceived at the **front edge of the tongue**.
- Taste information from the **anterior two-thirds of the tongue** is carried by the **chorda tympani branch of the facial nerve**.
- Taste information from the **posterior one-third of the tongue** is carried by the **glossopharyngeal nerve**.
- These taste impulses are then carried to the **taste centre in the medulla**, and from there, to the **thalamus**, and then to the **motor cortex**.
- Ultimately, the impulses are interpreted in the **cerebral cortex** as the distinct sensation of taste.

Disorders of the Tongue:

Various conditions can affect the tongue:

- **Aglossia**: A rare condition characterised by the **complete absence of the tongue at birth**.
- **Ankyloglossia (Tongue-Tie)**: Occurs when the **lingual frenum** (the tissue connecting the tongue to the floor of the mouth) **tethers the tongue** to the mouth's floor. If it interferes with oral hygiene and feeding, a frenectomy (surgical release) may be indicated.
- **Hypoglossia**: A condition where the tongue is **congenitally short**.

- **Macroglossia**: Refers to an **abnormally large tongue**, often seen in certain disorders such as Down syndrome.
- **Cleft Tongue**: A rare condition caused by a **failure of the lateral lingual swellings to merge** during development. A more common presentation is an **incompletely cleft tongue**, appearing as a midline fissure, which is normally classified as a **fissured tongue**.
