



B. Pharmacy 1st Semester - Human Anatomy and Physiology 1 Notes

UNIT – 4



Topics Covered in This Unit:

→ PERIPHERAL NERVOUS SYSTEM 

→ SPECIAL SENSES    



PERIPHERAL NERVOUS SYSTEM



INTRODUCTION

The peripheral nervous system refers to parts of the nervous system outside the brain and spinal cord. It includes the cranial nerves, spinal nerves and their roots and branches, peripheral nerves, and neuromuscular junctions. This system serves as the communication network between the central nervous system and the rest of the body.



CRANIAL NERVES AND THEIR PAIRS

Definition and Classification

Cranial nerves are twelve pairs of nerves attached to the brain. These nerves may be classified into three categories:

1. **Sensory:** Carrying impulses to the brain
2. **Motor:** Carrying impulses from the brain to the periphery

3. **Mixed:** Containing both sensory and motor fibers

The Twelve Pairs of Cranial Nerves

S.No.	Cranial Nerve	Type	Function
1	Olfactory nerve	Sensory	Nerve of smell
2	Optic nerve	Sensory	Nerve of vision
3	Oculomotor nerve	Motor	Supplies muscles of eyeball
4	Trochlear nerve	Motor	Supplies muscles of eyeball
5	Trigeminal nerve	Mixed	Sensory fibers to face and forehead; Motor fibers to muscles of mastication
6	Abducent nerve	Motor	Supplies muscles of eyeball
7	Facial nerve	Mixed	Supplies muscles of expression
8	Auditory nerve	Sensory	Cochlear nerve (hearing) and Vestibular nerve (equilibrium)
9	Glossopharyngeal nerve	Mixed	Sensory to tongue; Motor to pharyngeal muscles
10	Vagus nerve	Mixed	Distributed to pharynx, larynx, lungs, heart, stomach, and intestine
11	Accessory nerve	Motor	One part joins vagus (pharynx/larynx); Other part supplies neck muscles
12	Hypoglossal nerve	Motor	Supplies muscles of tongue

SPINAL NERVES

Spinal nerves are the major nerves of the body. A total of 31 pairs of spinal nerves control motor, sensory, and other functions. These nerves can be

impacted by various medical conditions, resulting in pain, weakness, or decreased sensation.

Nerve Plexuses

At certain regions of the spinal cord, individual nerve trunks unite to form plexuses. The four main plexuses are:

1. Cervical Plexus

- Formed by the first four cervical nerves
- Important branch: Phrenic nerve (supplies the diaphragm)

2. Brachial Plexus

- Formed by lower four cervical nerves and first thoracic nerve
- Important branches:
 - Circumflex nerve
 - Musculo cutaneous nerve
 - Radial nerve
 - Ulnar nerve
 - Median nerve

3. Lumbar Plexus

- Formed by the first four lumbar nerves
- Main branches: Femoral nerve and obturator nerve

4. Sacral Plexus

- Formed by 4th and 5th lumbar nerves and five sacral nerves

- Main branch: Sciatic nerve
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SENSATION AND SENSORY PATHWAY

Types of Sensations

Sensations can be classified into two types:

1. **Special sensation** - Felt by specialized organs (smell, taste, sight, hearing)
2. **General sensation** - Felt by all parts of the body

Sensory Pathway

The pathway of sensory impulses follows these steps:

1. Peripheral nerves carry superficial and deep sensations toward the spinal cord
2. Sensory fibers enter the posterior horn of gray matter through posterior nerve root
3. Fibers travel by different paths:
 - **Superficial sensations:** Travel upward in anterior column of spinal cord
 - **Deep sensations:** Travel upward in posterior column of spinal cord
4. Both fiber types cross to the opposite side at the medulla oblongata level
5. Impulses are conveyed to sensory areas of brain through brain stem, thalamus, and white matter

Motor Pathway

The motor path for voluntary movements consists of two neurons:

- **Upper motor neuron**
 - **Lower motor neuron**
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⚡ **AUTONOMIC NERVOUS SYSTEM**

📖 **Introduction**

The autonomic nervous system is a component of the peripheral nervous system that regulates involuntary physiologic processes including heart rate, blood pressure, respiration, digestion, and sexual arousal. It contains two anatomically distinct divisions: **Sympathetic** and **Parasympathetic**.

🔥 **SYMPATHETIC NERVOUS SYSTEM**

Structure

1. A pair of sympathetic chains are located on either side of the vertebral column
2. At the lower end, the two chains unite to form Ganglion impar
3. Each sympathetic chain has four parts:
 - Cervical part
 - Thoracic part
 - Lumbar part
 - Sacral part

Preganglionic Fibers

- Arise from lateral horn cells of the spinal cord
- Pass through anterior nerve roots of spinal nerves
- Run briefly in the spinal nerve
- Communicate to ganglia through White rami communicantes

Postganglionic Fibers

- Formed by Gray rami communicantes from sympathetic chain ganglia
- Enter spinal nerve at the same level and reach target organs
- Some fibers may ascend to higher or descend to lower ganglia
- Exit through gray rami communicantes and enter spinal nerves

Chemical Transmitters (Neurotransmitters)

1. **Preganglionic sympathetic nerve:** Acetylcholine (liberated at ganglion)
2. **Postganglionic sympathetic nerve ending:** Noradrenaline

Adrenergic Receptors

Receptors at postganglionic sympathetic nerve endings are classified as:

1. **Alpha receptors:** Action is excitatory (except intestine)
2. **Beta receptors:** Action is inhibitory (except heart)

PARASYMPATHETIC NERVOUS SYSTEM

Preganglionic Fibers

Arise from cells in:

1. **Midbrain**
2. **Medulla**
3. **Sacral portion** (2nd, 3rd, and 4th lumbar segments)

These fibers pass through anterior roots of corresponding spinal nerves.

Postganglionic Fibers

Arise from ganglia and reach the structures they supply.

Neurotransmitters

1. **Preganglionic parasympathetic nerve:** Acetylcholine (liberated at ganglion)
2. **Postganglionic parasympathetic nerve ending:** Acetylcholine

Cholinergic Receptors

Receptors for acetylcholine are present at:

1. **Both sympathetic and parasympathetic ganglia:** Nicotinic receptors
2. **Postganglionic parasympathetic nerve endings:** Muscarinic receptors



SPECIAL SENSES



Introduction

An organ of the body that responds to external stimuli by conveying impulses to the sensory nervous system. There are five sense organs: eyes, ears, nose, tongue, and skin.

EYE

Introduction

The eye is the sensory organ of vision, situated in the orbital cavity of the skull. It is globular in shape with a diameter of approximately 2.5 cm.

Main Functions of the Eye

- **Light Detection:** Every object reflects light
- **Night Vision:** Less light makes objects harder to see in darkness
- **Focus:** The eye functions like a camera with a lens
- **Depth Perception**
- **Balance**

STRUCTURES OF THE EYE

1. Eyebrows

- Two arches of thick skin over the eyes
- Contain thick hairs
- Prevent dripping of sweat, dust, or foreign particles into eyes

2. Eyelids

- Two movable folds of tissue above and below each eye

- Spread moisture over eyes when blinking

3. Lacrimal Apparatus

- Concerned with tear production
- Consists of lacrimal glands and duct system
- Tears have antibacterial function and lubricate the front part of the eye

4. Extrinsic Muscles of Eye

The eyeball is moved by six muscles:

Muscle	Movement
Superior rectus	Moves eye upward
Inferior rectus	Moves eye downward
Medial rectus	Moves eye inward
Lateral rectus	Moves eye outward
Inferior oblique	Moves eye up and outward
Superior oblique	Moves eye down and outward

STRUCTURE OF EYEBALL

The eyeball is almost spherical and contains:

1. **Three coats**
2. **Light transmitting structures**

THREE COATS

Outer Fibrous Coat:

- **Sclera:** Forms the white of the eye; has rich blood supply; muscles attach to its surface; covered by conjunctiva
- **Cornea:** Transmits light; has no blood vessels; richly supplied by sensory nerves for pain sensation

Middle Vascular Coat:

- **Choroid:** Thin tissue layer between sclera and retina
- **Ciliary Body:** Contains ciliary muscle; secretes aqueous humor
- **Iris:** Anterior continuation of ciliary body; pigmented muscular curtain with pupil opening

Inner Nervous Coat:

- **Retina:** Photosensitive layer that senses light and sends images to brain

LIGHT TRANSMITTING STRUCTURES

Aqueous Humor:

- Fluid in anterior and posterior chambers
- Transparent, water-like fluid similar to plasma
- Low protein concentration
- Secreted by ciliary body

Lens:

- Nearly transparent biconvex structure
- Suspended behind iris

- Focuses light rays onto retina

Vitreous Humor:

- Clear gel-like substance
 - Occupies space behind lens and in front of retina
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MECHANISM OF VISION

1. Light enters through the cornea
2. Iris and pupil regulate light amount
3. Image is focused through lens onto retina
4. Pigmented choroid darkens eye interior
5. Image stimulates rod and cone receptors in retina
6. Impulses carried through optic nerve
7. Optic nerves cross at optic chiasma
8. Impulses carried by optic tract to visual cortex in occipital lobe



DISEASES OF THE EYE

Disease	Characteristics
Myopia (short sight)	Distant objects cannot be seen clearly
Hypermetropia (long sight)	Near objects cannot be seen clearly
Presbyopia	Accommodation defect in old age due to lens elasticity loss
Glaucoma	May lead to blindness due to retinal damage
Color blindness	Retinal defect preventing color perception
Night blindness (Nyctolopia)	Inability to see in dim light; vitamin A deficiency
Cataract	Opacity of the lens
Diplopia	Double vision
Xerophthalmia	Dryness of eyes
Keratomalacia	Cornea becomes soft and may perforate

EAR

Introduction

The ear is concerned with hearing and equilibrium functions. It is divided into three parts: External ear, Middle ear, and Internal ear.

EXTERNAL EAR

The only part lying outside the skull, containing:

1. Pinna or Auricle

- Funnel-shaped organ made of elastic fibrocartilage
- Helps collect sound waves

2. External Auditory Meatus

- Small channel lined by skin and wax-secreting glands
- Conveys sound vibrations to tympanic membrane



MIDDLE EAR (TYMPANIC CAVITY)

Small cavity in temporal bone containing:

1. **Tympanic membrane (eardrum)** - Forms lateral wall
2. **Tensor tympani and stapedius muscles**
3. **Two foramina:** Fenestra ovalis (oval window) and Fenestra rotundum (round window)
4. **Eustachian tube** - Connects middle ear with nasopharynx
5. **Auditus** - Narrow channel connecting with mastoid antrum
6. **Auditory ossicles** - Three small bones: Malleus, Incus, and Stapes



INNER EAR

Also called labyrinth of the ear, containing organs for hearing and equilibrium.

THE BONY LABYRINTH

Divided into three sections:

Vestibule:

- Central part
- Contains utricle and saccule

Cochlea:

- Spiral canal resembling snail shell
- **Modiolus:** Central column of spongy bone
- **Basilar membrane:** Divides cochlea into scala vestibuli (upper) and scala media (lower)
- **Organ of Corti:** Auditory receptor on basilar membrane

Semicircular Canals:

- Three canals per ear: posterior, superior, and lateral
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MECHANISM OF HEARING

1. Sound waves collected by pinna
2. External auditory meatus directs waves to tympanic membrane
3. Vibrations transmitted by malleus, incus, and stapes to fenestra ovalis
4. Vibrations transmitted to organ of Corti through perilymph and endolymph
5. Impulses carried to brain stem through cochlear portion of 8th cranial nerve
6. Fibers carried to auditory center in opposite temporal lobe



MECHANISM OF EQUILIBRIUM

- Endolymph movement stimulates nerve endings in ampullae

- Impulses carried through vestibular portion of 8th cranial nerve
- Impulses produce sensations about head position
- Allows adjustment to maintain balance and equilibrium



COMMON DISEASES OF THE EAR

1. **Meniere's Syndrome:** Hearing loss due to membranous labyrinth distension
 2. **Eustachitis:** Inflammation of Eustachian tube
 3. **Tympanitis:** Inflammation of eardrum
 4. **Otalgia:** Ear pain
 5. **Otitis media:** Acute middle ear infection
 6. **Presbycusis:** Age-related hearing loss (30-35% of adults 65+)
 7. **Benign paroxysmal positional vertigo (BPPV):** Common cause of vertigo
 8. **Otosclerosis:** Abnormal bone growth affecting stapes mobility
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SKIN



Introduction

Skin is the largest organ in the body, forming a protective covering in contact with the external environment. It plays an important role in body temperature regulation.



STRUCTURE OF SKIN

Skin consists of two layers:

1. **Epidermis** (outer layer)
2. **Dermis** (inner layer)

EPIDERMIS

Composed of stratified squamous epithelium, divided into five layers:

1. **Stratum Corneum:** Most superficial layer; contains keratin; nuclei absent
2. **Stratum Lucidum:** Thin, transparent, glistening layer with cytoplasm
3. **Stratum Granulosum:** Contains spindle-shaped cells with cytoplasm and nucleus
4. **Stratum Spinosum:** Contains polyhedral cells
5. **Stratum Germinativum:** Single layer of columnar/cuboidal cells; connected to dermis; contains melanin pigments

DERMIS

Composed of highly vascular connective tissue made of fibroelastic tissue maintaining skin texture.

Glands of the Dermis:

1. **Sebaceous Glands:**

- Flask-shaped glands secreting sebum
- Prevent water evaporation and skin drying
- Present everywhere except palms and soles

2. **Sweat Glands:**

- **Eccrine glands:** Present all over body; secrete watery sweat

- **Apocrine glands:** Present in axilla, genitalia, nipples; secrete milky sweat

3. **Ceruminous Glands:** Secrete wax in external ear

4. **Hair Roots and Erector Pili Muscles:** Contraction produces hair straightening

FUNCTIONS OF SKIN

1. Protects against injury and bacterial invasion
2. Regulates body temperature
3. Receives sensations (touch, pressure, temperature)
4. Excretes sodium chloride and metabolites like urea
5. Maintains water and electrolyte balance
6. Synthesizes vitamin D from ergosterol using UV rays
7. Synthesizes melanin from tyrosine
8. Secretes sweat and sebum keeping skin soft
9. Stores fat, water, chlorides, and sugar

REGULATION OF BODY TEMPERATURE

Normal body temperature is 98.4°F (37°C), maintained by balance between heat production and heat loss, controlled by the hypothalamus heat regulating center.

Heat Production:

1. Severe exercise and increased muscle activity

2. Increased liver and gland activity
3. Increased protein food intake
4. Increased metabolism and fat combustion
5. Endocrine secretions (adrenaline, noradrenaline)

Heat Loss:

1. **Radiation:** Body heat lost to surrounding air
2. **Conduction:** Heat lost through clothing, bedding
3. **Convection:** Hot air replacement by cool air
4. **Sweating:** Skin cooling leading to heat loss
5. **Evaporation:** Water evaporation from skin, mucous membranes, respiratory passages



DISORDERS OF SKIN

- **Acne:** Blocked skin follicles causing oil, bacteria, and dead skin buildup
- **Alopecia areata:** Hair loss in small patches
- **Atopic dermatitis (eczema):** Dry, itchy, swollen skin
- **Psoriasis:** Scaly, swollen, hot skin
- **Raynaud's phenomenon:** Reduced blood flow to extremities
- **Rosacea:** Thick skin and pimples, usually facial
- **Skin cancer:** Uncontrolled abnormal skin cell growth
- **Vitiligo:** Patches of skin losing pigment



NOSE

Introduction

The nose is part of the respiratory system, allowing air entry while filtering debris and warming/moistening air. It provides smell sensation and helps shape appearance. The sensory nerves of smell are the olfactory nerves.

PARTS OF NOSE

- **Bone:** Hard bridge at nose top
- **Hair and cilia:** Trap dirt and particles
- **Lateral walls:** Made of cartilage covered in skin
- **Nasal cavities:** Two hollow spaces for air flow
- **Nerve cells:** Communicate with brain for smell
- **Nostrils (nares):** Facial openings to nasal cavities
- **Septum:** Made of bone and firm cartilage
- **Sinuses:** Four pairs
- **Turbinates (conchae):** Three pairs along nasal cavity sides

SENSATION OF SMELL

1. Olfactory cells are smell receptors
2. Located in upper nasal cavity mucous membrane
3. Olfactory rod ends form olfactory nerve
4. Nerve passes through nose root to olfactory bulb
5. Sensations carried through olfactory tract to temporal lobe olfactory area
6. Smell perception occurs in this area

FUNCTIONS

- Sense of smell
- Air cleaning by nasal hair
- Conditioning inhaled air (warming, humidifying)
- Lower airway protection
- Paranasal sinus ventilation and drainage
- Enhanced olfaction through sniffing
- Nasal resistance
- Vocal resonance
- Nasal reflexes



DISORDERS OF NOSE

- **Allergic rhinitis:** Nasal membrane inflammation
- **Cerebral spinal fluid leaks**
- **Chronic sinusitis:** With or without polyps
- **Fungal sinusitis:** Various types including allergic and invasive forms
- **Inverting papilloma:** Benign nasal tumors
- **Meningoencephalocele:** Brain tissue protrusion through skull opening
- **Nasal fractures**
- **Nasal masses and tumors**

TONGUE

Introduction

The tongue is a muscular organ in the mouth that manipulates food for mastication and is used in swallowing. It is a mobile organ situated within the mouth.

DESCRIPTION

The central tongue surface connects to the mouth floor by frenulum linguae. The anterior 2/3 portion has taste papillae.

Three types of taste papillae:

- Circumvallate papillae
- Fungiform papillae
- Filiform papillae

PARTS OF THE TONGUE

1. **Tip:** Highly agile part with sweet taste buds
2. **Root:** Attaches tongue to mouth floor
3. **Dorsum:** Curved upper surface toward back
4. **Ventral surface:** Underneath the tongue
5. **Borders:** Tongue sides

FUNCTIONS OF THE TONGUE

1. Organ of taste (sweet, salt, bitter, sour)
2. Helps in food mastication (chewing)
3. Assists in swallowing

4. Helps clean lips

5. Aids in speech



SENSATION OF TASTE

The tongue is mainly concerned with taste sensation. On the anterior 2/3 dorsum are taste papillae called taste buds - the end organs of taste:

Taste	Location
Sweet	Tip of tongue
Salt	Back of tongue
Sour	Back edge of tongue
Bitter	Front edge of tongue

Nerve Pathways:

- Anterior 2/3 taste carried by chorda tympani branch of facial nerve
- Posterior 1/3 taste carried by glossopharyngeal nerve
- Impulses travel to medulla taste center, then thalamus, then motor cortex
- Interpretation occurs in cerebral cortex as taste sensation



DISORDERS OF TONGUE

- **Aglossia:** Complete tongue absence at birth
- **Ankyloglossia:** Lingual frenum tethers tongue to mouth floor
- **Hypoglossia:** Congenitally short tongue
- **Macroglossia:** Abnormally large tongue (seen in Down syndrome)

- **Cleft tongue:** Complete or incomplete tongue cleft due to lateral lingual swelling merger failure
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This completes the comprehensive coverage of Unit 4: Peripheral Nervous System and Special Senses for B. Pharmacy 1st Semester Human Anatomy and Physiology.

