

## Unit 4: Anatomy of the Endocrine and Nervous Systems

### Subject: Human Anatomy

### Unit 4: Anatomy of the Endocrine and Nervous Systems

*(Endocrine System—Gland Types & Key Glands • Nervous System—Classification • Brain & Spinal Cord • Sensory Organs with Applied Anatomy)*

## 4.1 Endocrine System — Gland Types and Hormone Basics

**Endocrine anatomy** studies **ductless glands** that release **hormones** into blood to regulate growth, metabolism, reproduction, stress, and fluid-electrolyte balance. Unlike exocrine glands (which have ducts and secrete onto surfaces), endocrine glands signal **at a distance** and work through **feedback loops**.

### 4.1.1 Types of glands (structure & distribution)

| Type                                 | Examples  | Characteristics                                  |
|--------------------------------------|---|--|
| <b>Discrete endocrine glands</b>     | Pituitary, thyroid, parathyroids, adrenals, pineal  | Well-defined organs; rich blood supply           |
| <b>Mixed (endo-exocrine) glands</b>  | Pancreas (islets/endocrine; acini/exocrine), gonads | Endocrine tissue embedded within other functions |
| <b>Diffuse neuroendocrine system</b> | Enteroendocrine cells (gut), adipocytes (leptin)    | Scattered hormone-secreting cells across organs  |

### 4.1.2 Hormone classes & receptors

| Class                           | Examples  | Receptors/Action  |
|---------------------------------|---|---|
| <b>Peptide/protein</b>          | GH, insulin, ADH, ACTH                                      | Bind <b>cell-surface</b> receptors → second messengers (cAMP, IP <sub>3</sub> )                     |
| <b>Steroid</b>                  | Cortisol, aldosterone, estrogen/testosterone                | <b>Intracellular</b> receptors → gene transcription   |
| <b>Amine (tyrosine-derived)</b> | T <sub>3</sub> /T <sub>4</sub> , epinephrine/norepinephrine | T <sub>3</sub> /T <sub>4</sub> act like steroids (nuclear); catecholamines act on surface receptors |

### 4.1.3 Feedback & rhythms (clinically useful)

- **Negative feedback:** rising hormone output inhibits its own stimulation (e.g., T<sub>3</sub>/T<sub>4</sub> suppress **TRH/TSH**).
- **Axes:** **HPA** (hypothalamus-pituitary-adrenal), **HPT** (...thyroid), **HPG** (...gonadal).
- **Rhythms:** **circadian** cortisol (highest early morning), **ultradian** GH pulses during sleep.

**Applied link (Yoga):** regular **sleep**, **light exposure**, and **stress-modulating breathwork** support endocrine rhythms (e.g., morning light + consistent bedtime stabilize cortisol-melatonin balance).

## 4.2 Importance of Key Endocrine Glands

### 4.2.1 Pituitary (Hypophysis) — “Master” gland

- **Location:** sella turcica; connected to **hypothalamus** via **infundibulum**.
- **Lobes:**
  - **Anterior (adenohypophysis):** TSH, ACTH, GH, PRL, LH, FSH.
  - **Posterior (neurohypophysis):** stores/releases **ADH (vasopressin)** & **oxytocin** (made in hypothalamus).

### Clinical notes & practice sense



- **ADH:** water retention; deficiency → **diabetes insipidus** (polyuria/polydipsia). Ensure **hydration** in classes.
- **GH:** growth & metabolism; excess → acromegaly.
- **Space-occupying lesions** may compress **optic chiasm** → **bitemporal hemianopia** (screen for visual field complaints).

#### 4.2.2 Thyroid

- **Anatomy:** butterfly-shaped, anterior neck, **follicles** filled with colloid (thyroglobulin).
- **Hormones:** **T<sub>4</sub> (thyroxine)** → **T<sub>3</sub>** (active), **calcitonin** from C-cells (minor Ca<sup>2+</sup> effect).
- **Functions:** basal metabolic rate, thermogenesis, cardiac output, growth, CNS maturation.

#### Disorders (red flags & yoga considerations)

- **Hypothyroidism:** cold intolerance, weight gain, bradycardia → prefer **gentle warm-ups**, pacing.
- **Hyperthyroidism:** heat intolerance, tachycardia, tremor → avoid **overheating** and **forceful pranayama**; emphasize **cooling, calming** practices.
- **Goitre/Iodine deficiency:** neck swelling; ensure comfortable head/neck positions.

#### 4.2.3 Parathyroids

- **Four tiny glands** on posterior thyroid.
- **PTH** raises **serum Ca<sup>2+</sup>** (bone resorption, renal Ca<sup>2+</sup> reabsorption, activates vitamin D → ↑ gut Ca<sup>2+</sup> absorption).
- **Hypocalcemia** → **tetany**, paresthesias; **hypercalcemia** → “stones, bones, abdominal groans.”

**Practice pearl:** prolonged **over-breathing** (respiratory alkalosis) reduces ionized Ca<sup>2+</sup> and can **precipitate cramps**; therefore keep **pranayama smooth**, avoid aggressive hyperventilation.

#### 4.2.4 Adrenal (Suprarenal) glands

- **Cortex (G-F-R):**
  - **Zona glomerulosa** → **aldosterone** (Na<sup>+</sup>/K<sup>+</sup> balance, BP).
  - **Zona fasciculata** → **cortisol** (stress, glucose, anti-inflammatory).
  - **Zona reticularis** → **androgens**.
- **Medulla:** **chromaffin** cells → **epinephrine/norepinephrine** (fight-or-flight).

#### Disorders & cues

- **Cushing's** (cortisol excess): central obesity, striae, HTN.
- **Addison's** (adrenal insufficiency): fatigue, weight loss, **postural hypotension**—teach **slow transitions**, hydration, and monitoring.
- **Stress physiology:** slow **exhale-lengthened breathing** supports **vagal tone** and reduces sympathetic over-drive.

#### HPA flow (simplified):

Stress → **Hypothalamus (CRH)** → **Pituitary (ACTH)** → **Adrenal cortex (Cortisol)** → feedback ↓ CRH/ACTH.

## 4.3 Nervous System — Classification & Functional Logic

### 4.3.1 Structural & functional map

| Division   | Components                                      | Function                              |
|------------|---|---------------------------------------|
| <b>CNS</b> | Brain + spinal cord                             | Integration, planning, reflex centers |
| <b>PNS</b> | Cranial nerves (I–XII), spinal nerves & ganglia | Link CNS to body                      |



| Division        | Components   | Function  |
|-----------------|--|---|
| Somatic         | Motor to skeletal muscle; sensory from skin/joints | Voluntary movement; conscious sensation               |
| Autonomic (ANS) | Sympathetic, Parasympathetic, Enteric              | Visceral motor control (heart, glands, smooth muscle) |

### 4.3.2 ANS snapshot (high-yield table)

| Target      | Sympathetic (T1-L2)       | Parasympathetic (CN III, VII, IX, X; S2-S4) |
|-------------|---------------------------|---|
| Heart       | ↑ rate/contractility      | ↓ rate                                      |
| Bronchi     | Dilate                    | Constrict                                   |
| Pupil       | <b>Dilate</b> (mydriasis) | <b>Constrict</b> (miosis)                   |
| GI motility | ↓                         | ↑   |
| Bladder     | Sphincter close           | Detrusor contract (voiding)                 |

**Yoga link:** slow nasal breathing with a **longer exhale** biases **parasympathetic** tone; aggressive breath-holds or intense strain spike sympathetic output.

### 4.3.3 Neural tissue

- **Neuron:** soma, dendrites, axon (myelinated or unmyelinated).
- **Glia:** CNS—**astrocytes, oligodendrocytes, microglia, ependymal**; PNS—**Schwann** (myelin), **satellite** cells.
- **Synapse & transmitters:** glutamate (excitatory), GABA (inhibitory), acetylcholine, monoamines (NE, dopamine, serotonin).

## 4.4 Brain and Spinal Cord – Structure & Highlights

### 4.4.1 Brain regions

| Region               | Key parts   | Functions (clinically relevant)                                      |
|----------------------|---|--|
| <b>Cerebrum</b>      | <b>Frontal</b> (motor, executive, Broca), <b>Parietal</b> (somatosensory), <b>Temporal</b> (hearing, Wernicke, memory), <b>Occipital</b> (vision) | Voluntary movement, language, perception                             |
| <b>Diencephalon</b>  | <b>Thalamus</b> (relay), <b>Hypothalamus</b> (homeostasis, endocrine), <b>Epithalamus/Pineal</b>  | Autonomic & endocrine control  |
| <b>Basal ganglia</b> | Caudate, putamen, globus pallidus   | Movement initiation; affected in Parkinson disease                   |
| <b>Cerebellum</b>    | Vermis, hemispheres   | Coordination, balance, error correction                              |
| <b>Brainstem</b>     | <b>Midbrain, Pons, Medulla</b>  | Vital centers, cranial nerves III-XII, arousal (reticular formation) |

**Meninges & CSF:** **dura-arachnoid-pia**; **CSF** formed by **choroid plexus** in ventricles → circulates through ventricles → subarachnoid space → drains via arachnoid villi.

**Blood supply:** **internal carotid & vertebral** systems forming **Circle of Willis**.

### 4.4.2 Spinal cord

- **Extent:** foramen magnum → **L1-L2** (adult); **conus medullaris** → **cauda equina**.
- **Gray matter horns:** **dorsal (sensory), ventral (motor), lateral (T1-L2 sympathetic)**.
- **Ascending tracts:** **dorsal columns** (fine touch, proprioception), **spinothalamic** (pain/temp).
- **Descending tract:** **corticospinal** (voluntary motor).
- **Reflex arc:** receptor → afferent → **spinal center** → efferent → effector (e.g., knee jerk L3-L4).

**Dermatomes:** skin zones supplied by single spinal nerves (e.g., **thumb C6, umbilicus T10, knee L4**).

**Plexuses & key nerves:**

- **Cervical (C1-C4)**—phrenic (C3-C5) **keeps diaphragm alive.**
- **Brachial (C5-T1)**—**median** (carpal tunnel), **ulnar, radial.**
- **Lumbosacral**—**sciatic, femoral, tibial, peroneal.**

## 4.5 Sensory Organs — Structure & Applied Notes

### 4.5.1 Eye (Organ of vision)

- **Coats: Fibrous** (sclera, **cornea**), **Vascular** (choroid, ciliary body, **iris**), **Neural (retina).**
- **Lens & accommodation:** ciliary muscle alters lens curvature for near/far focus.
- **Aqueous humor flow:** ciliary processes → posterior chamber → pupil → anterior chamber → **trabecular meshwork** → **Schlemm canal.**
- **Photoreceptors: rods** (dim light) & **cones** (color, acuity in **fovea**).
- **Optic pathway:** retina → **optic nerve** → chiasm (nasal fibers cross) → tract → **lateral geniculate** → visual cortex.

**Applied (practice cautions)**

- **Glaucoma** (raised IOP): avoid **prolonged inversions/Valsalva**; prefer **head-neutral** options.
- **Refractive errors:** trataka should be **gentle & brief** to avoid strain.
- **Diabetic/hypertensive retinopathy:** prioritize **blood pressure/sugar control**; avoid high-pressure breath-holds.

### 4.5.2 Ear (Hearing & balance)

- **External:** auricle, **external auditory canal.**
- **Middle:** **tympanic membrane**, ossicles (malleus, incus, stapes), **Eustachian tube.**
- **Inner: cochlea** (hearing; Organ of Corti), **vestibular apparatus—semicircular canals** (angular acceleration), **utricle/sacculle** (linear acceleration).

**Applied**

- **Otitis media** in children (short, horizontal Eustachian tube).
- **BPPV** (otoliths in semicircular canals): positional vertigo—use **slow head transitions**, introduce **balance training** progressively.
- **Hearing conservation:** mindful volume in guided sessions.

### 4.5.3 Taste, Smell & Somatic sensation (brief)

- **Taste (gustation):** tongue papillae; modalities—sweet, salty, sour, bitter, umami; CN VII, IX, X.
- **Smell (olfaction):** olfactory epithelium → CN I; closely linked to **limbic** emotions/memory.
- **Touch/Proprioception/Pain:** skin mechanoreceptors; **muscle spindles** and **Golgi tendon organs** inform alignment—refined by **slow, attentive movement.**

## 4.6 Integrated Applied Anatomy (Yoga & Naturopathy)

- **Autonomic balance: exhale-lengthened nasal breathing** enhances **parasympathetic tone** (lower HR, calmer mind); avoid forceful hyperventilation in panic-prone or hypocalcemic states.
- **Endocrine rhythm hygiene:** consistent **sleep-wake, morning light, and evening screen limits** support **cortisol-melatonin** cycles.
- **Thyroid considerations:** hyperthyroid clients may tolerate **cooling, restorative** sessions; hypothyroid clients may need **longer warm-ups** and **gradual pacing.**



- **Adrenal insufficiency:** watch for **dizziness on standing**; cue **slow postural changes**, hydration, and check-ins.
- **Eye safety: glaucoma**—prefer **non-inverted** head positions; **dry eye**—blink breaks during visual focus practices.
- **Spinal safety:** protect **dorsal columns** tasks (balance) with **progressive difficulty**; avoid extreme end-range flexion/rotation with load.

## Unit Summary

The **endocrine system** uses hormones (peptide, steroid, amine) to coordinate whole-body physiology via feedback loops like **HPA** and **HPT**. Four headline glands—**pituitary, thyroid, parathyroid, adrenal**—govern water balance, metabolism, calcium homeostasis, and stress responses. The **nervous system** integrates sensation and action through the **CNS** and **PNS**, with the **ANS** balancing sympathetic and parasympathetic outflow. The **brain** (cerebrum, diencephalon, brainstem, cerebellum) and **spinal cord** (tracts, reflexes) organize behavior, while **sensory organs** (eye, ear, taste, smell, somatic receptors) link us to the environment. Applied insights inform safe, effective Yoga & Naturopathy: breathe to regulate the ANS, respect ocular and cardiovascular cautions, pace practice for thyroid/adrenal conditions, and protect spinal and vestibular integrity.

## Key Terms

- Peptide/Steroid/Amine hormones • HPA/HPT/HPG axes • Negative feedback
- ADH, Oxytocin, GH, TSH, ACTH, LH/FSH • T<sub>3</sub>/T<sub>4</sub>, Calcitonin, PTH
- Aldosterone, Cortisol, Catecholamines • Sympathetic/Parasympathetic
- Dorsal columns, Spinthalamic, Corticospinal • Meninges, CSF
- Aqueous humor, Schlemm canal • Cochlea, Semicircular canals • Dermatome

## Self-Assessment

### MCQs

1. **T<sub>3</sub>/T<sub>4</sub>** primarily exert their effects via:  
a) Cell-surface GPCRs b) Nuclear receptors altering gene transcription c) Ion channels d) Enzyme replacement
2. **Bitemporal hemianopia** may result from a lesion compressing the:  
a) Optic nerve b) Optic chiasm c) Lateral geniculate body d) Primary visual cortex
3. **PTH** increases serum calcium by all **except**:  
a) Increasing bone resorption b) Increasing renal Ca<sup>2+</sup> reabsorption c) Decreasing vitamin D activation d) Increasing intestinal Ca<sup>2+</sup> absorption (via vitamin D)
4. **Dorsal column** damage most directly impairs:  
a) Pain and temperature b) Fine touch and proprioception c) Motor strength d) Vision
5. A **parasympathetic** effect is:  
a) Bronchodilation b) Pupil dilation c) Decreased heart rate d) Reduced GI motility
6. **Aqueous humor** drains primarily through the:  
a) Eustachian tube b) Canal of Schlemm c) Cochlear duct d) Lymphatics

**Answer key:** 1-b, 2-b, 3-c, 4-b, 5-c, 6-b

### Short Answer

1. Outline the **HPA axis** and one way chronic stress alters physiology.
2. List the **hormones** from the **anterior** and **posterior** pituitary and give one action each.
3. Differentiate **sympathetic** and **parasympathetic** effects on the **heart, bronchi, and pupils**.



4. Describe the **CSF pathway** from formation to absorption and mention one function of CSF.
5. Sketch a labeled diagram or write a brief note on **aqueous humor circulation** and relate it to **glaucoma**.

### Reflective/Application

1. Plan a **15-minute breath-led practice** for a client with exam stress. State the autonomic goal and two safety checks.
2. A participant reports **positional vertigo** when lying down and turning the head. Which sensory organ is likely involved, and how will you **modify transitions** and **balance work** in class?
3. Your class includes a person with **hyperthyroidism**. What **thermal, pacing, and breath** choices will you make, and what will you avoid?

*End of Unit 4: Anatomy of the Endocrine and Nervous Systems*