

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

4.1.2 Hormone classes & receptors

Class	Examples	Receptors/Action
Peptide/protein	GH, insulin, ADH, ACTH	Bind cell-surface receptors → second messengers (cAMP, IP ₃)
Steroid	Cortisol, aldosterone, estrogen/testosterone	Intracellular receptors → gene transcription
Amine (tyrosine-derived)	T ₃ /T ₄ , epinephrine/norepinephrine	T ₃ /T ₄ 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., T₃/T₄ 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:** **T₄ (thyroxine)** → **T₃** (active), **calcitonin** from C-cells (minor Ca²⁺ 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 Ca²⁺** (bone resorption, renal Ca²⁺ reabsorption, activates vitamin D → ↑ gut Ca²⁺ absorption).
- **Hypocalcemia** → **tetany**, paresthesias; **hypercalcemia** → “stones, bones, abdominal groans.”

Practice pearl: prolonged **over-breathing** (respiratory alkalosis) reduces ionized Ca²⁺ 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⁺/K⁺ 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
CNS	Brain + spinal cord	Integration, planning, reflex centers
PNS	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	Dilate (mydriasis)	Constrict (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)
Cerebrum	Frontal (motor, executive, Broca), Parietal (somatosensory), Temporal (hearing, Wernicke, memory), Occipital (vision)	Voluntary movement, language, perception
Diencephalon	Thalamus (relay), Hypothalamus (homeostasis, endocrine), Epithalamus/Pineal	Autonomic & endocrine control
Basal ganglia	Caudate, putamen, globus pallidus	Movement initiation; affected in Parkinson disease
Cerebellum	Vermis, hemispheres	Coordination, balance, error correction
Brainstem	Midbrain, Pons, Medulla	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 • T₃/T₄, 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. T₃/T₄ 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 Ca²⁺ reabsorption c) Decreasing vitamin D activation d) Increasing intestinal Ca²⁺ 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