

ENDOCRINE SYSTEM • PHARMACOLOGY • FOUNDATIONS

Endocrine Hormone Pathways

Hypothalamus–Pituitary–Target Gland axes • Negative feedback • Hyper- vs Hypo-function patterns

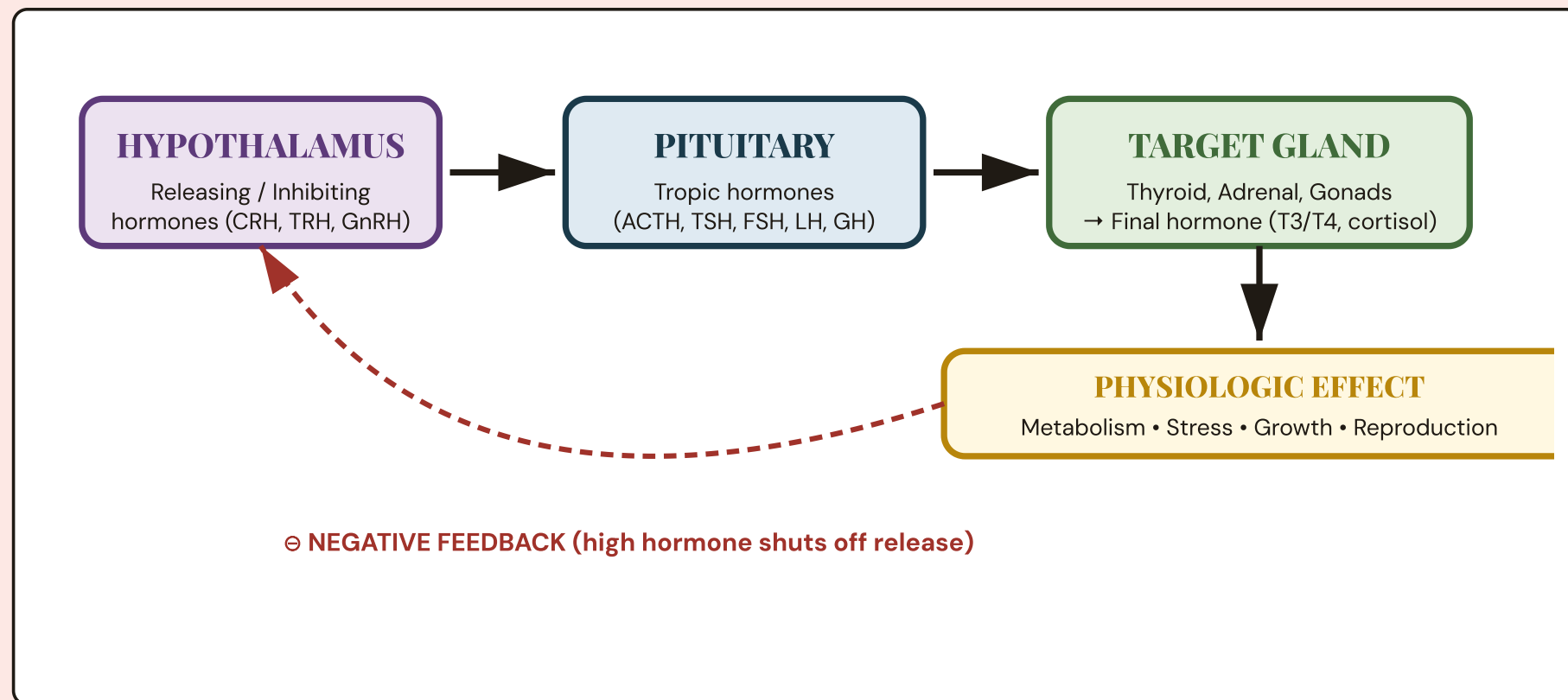
1 Definition / Overview

The endocrine system is a chemical communication network that uses **hormones** released into the bloodstream to regulate growth, metabolism, reproduction, fluid balance, and the stress response.

- ▶ **MASTER REGULATOR** The **hypothalamus** integrates signals from the brain and bloodstream and releases "releasing/inhibiting" hormones.
- ▶ **MASTER GLAND** The **pituitary** sits below the hypothalamus and releases hormones that act on peripheral target glands (thyroid, adrenals, gonads).
- ▶ **WHY IT MATTERS** Almost every chronic endocrine disorder reflects a problem in one of three places: *too much hormone, too little hormone, or a broken feedback loop.*

2 Pathophysiology — The 3-Tier Hierarchy

Hormone control flows in a predictable chain. Knowing the chain lets you classify any disorder as **primary** (target gland), **secondary** (pituitary), or **tertiary** (hypothalamus).



- ▶ **Primary disorder** = the target gland is broken. Example: *primary hypothyroidism* → thyroid fails → low T3/T4 → **TSH rises** as the pituitary tries harder.
- ▶ **Secondary disorder** = the pituitary is broken. Example: *secondary hypothyroidism* → low TSH → low T3/T4.
- ▶ **Negative feedback** works like a thermostat — when the final hormone is high enough, it tells the hypothalamus and pituitary to *stop*.

3 Anterior vs Posterior Pituitary

ANTERIOR PITUITARY (ADENOHYPOPHYSIS)

Makes & releases its own tropic hormones.

- ▶ **FSH** — Follicle stimulating
- ▶ **LH** — Luteinizing
- ▶ **ACTH** — Adrenocorticotrophic → cortisol
- ▶ **TSH** — Thyroid stimulating → T3/T4
- ▶ **Prolactin** — milk production
- ▶ **GH** — Growth hormone → IGF-1

MNEMONIC "FLAT PiG"

POSTERIOR PITUITARY (NEUROHYPOPHYSIS)

Stores & releases hormones made in the hypothalamus.

- ▶ **ADH** (vasopressin) — water reabsorption in kidneys
- ▶ **Oxytocin** — uterine contraction, milk ejection

MNEMONIC "ADH & Oxy go OUT the back" (posterior = back)

Clinical link: Too little ADH = *Diabetes Insipidus* (DI). Too much ADH = *SIADH*.

4 The 5 Major Hormone Axes

HPA Axis (Stress)

CRH → ACTH → Cortisol

- Raises blood glucose
- Suppresses immunity & inflammation
- Maintains BP under stress

EXCESS Cushing's **DEFICIT** Addison's

HPT Axis (Metabolism)

TRH → TSH → T3/T4

- Sets metabolic rate
- Regulates body temperature
- Supports growth & cognition

EXCESS Graves' **DEFICIT** Hashimoto's

HPG Axis (Reproduction)

GnRH → FSH/LH → Estrogen / Testosterone

- Puberty & secondary sex traits
- Menstrual cycle / spermatogenesis
- Bone density

NOTE Disrupted in stress, eating disorders

GH Axis (Growth)

GHRH → GH → IGF-1 (liver)

- Linear growth in children
- Anabolic — protein synthesis
- Mobilizes fat, raises glucose

EXCESS Gigantism (kids) / Acromegaly (adults) **DEFICIT** Dwarfism

Prolactin Axis (Lactation)

Dopamine ⊖ inhibits → Prolactin

- Milk production after birth
- Tonically suppressed by dopamine
- Anti-dopamine drugs ↑ prolactin

EXCESS Galactorrhea, amenorrhea, infertility

ADH Axis (Water Balance)

Hypothalamus → posterior pituitary → ADH → kidneys reabsorb water

- Triggered by ↑ serum osmolarity, ↓ BP
- Concentrates urine

↓ ADH DI = dilute, polyuria **↑ ADH** SIADH = concentrated, retention

5 Signs & Symptoms — Hyper vs Hypo by Gland

Thyroid (T₃/T₄)

HYPERTHYROID (GRAVES')

- ▶ ↑ HR, palpitations, A-Fib
- ▶ Heat intolerance, sweating
- ▶ Weight loss with ↑ appetite
- ▶ Exophthalmos, diarrhea, tremor
- ▶  **Thyroid storm:** T >105°F, tachy, delirium

HYPOTHYROID (HASHIMOTO'S)

- ▶ ↓ HR, fatigue, depression
- ▶ Cold intolerance, dry skin, hair loss
- ▶ Weight gain with ↓ appetite
- ▶ Constipation, bradycardia
- ▶  **Myxedema coma:** hypothermia, ↓ LOC

Adrenal Cortex (Cortisol)

CUSHING'S (↑ CORTISOL)

- ▶ Moon face, buffalo hump, truncal obesity
- ▶ Thin skin, purple striae, easy bruising
- ▶ Hyperglycemia, HTN
- ▶ ↑ infection risk (immunosuppression)
- ▶ Hypokalemia, osteoporosis

ADDISON'S (↓ CORTISOL)

- ▶ Hyperpigmentation (bronze skin)
- ▶ Hypotension, hypoglycemia
- ▶ Hyponatremia, hyperkalemia
- ▶ Weight loss, fatigue, salt craving
- ▶  **Addisonian crisis:** shock, give IV hydrocortisone STAT

Posterior Pituitary (ADH)

SIADH (↑ ADH)

- ▶ Water *retention* — dilutional **HYPONatremia**
- ▶ Concentrated urine, low UO
- ▶ Weight gain without edema
- ▶ HA, confusion, seizures (cerebral edema)
- ▶ **Tx:** fluid restrict, hypertonic saline, tolvaptan

DIABETES INSIPIDUS (↓ ADH)

- ▶ Massive dilute polyuria (5–20 L/day)
- ▶ **HYPER**natremia, ↑ serum osmolality
- ▶ Severe thirst, dehydration, hypotension
- ▶ Urine SG < 1.005
- ▶ **Tx:** Desmopressin (DDAVP) + free water

Growth Hormone (GH)

ACROMEGALY (↑ GH IN ADULTS)

- ▶ Enlarged hands, feet, jaw, brow ridge
- ▶ Coarse facial features, deep voice
- ▶ HTN, cardiomegaly, sleep apnea
- ▶ Insulin resistance / DM2

GH DEFICIENCY

- ▶ Children: short stature, delayed puberty
- ▶ Adults: ↓ muscle mass, ↑ fat, fatigue
- ▶ ↓ bone density
- ▶ **Tx:** recombinant somatropin SQ injections

6 Priority Nursing Interventions (ABCs first)

A Airway / Breathing

- ▶ **Monitor** for stridor post-thyroidectomy (laryngeal nerve damage, hematoma)
- ▶ **Assess** respiratory effort in myxedema coma — risk of CO₂ retention
- ▶ **Keep** trach kit at bedside x 24 hr after thyroid surgery

C Circulation

- ▶ **Monitor** HR/BP closely in thyroid storm and Addisonian crisis
- ▶ **Administer** IV fluids (NS) for DI, Addisonian crisis, dehydration
- ▶ **Continuous** cardiac monitoring with electrolyte shifts (K⁺ in Cushing's/Addison's)

Safety / Glucose

- ▶ **Check** blood glucose — Cushing's runs high, Addison's runs low
- ▶ **Seizure precautions** for SIADH (Na⁺ < 120) and severe hypoglycemia
- ▶ **Fall precautions** for osteoporosis (Cushing's, hyperparathyroid, post-menopausal)

Fluid & Electrolytes

- ▶ **Strict I&O** + daily weights (esp. DI, SIADH, Cushing's)
- ▶ **Monitor** Na⁺, K⁺, Ca²⁺, glucose, serum/urine osmolality
- ▶ **Fluid restrict** for SIADH; **free water access** for DI

Crisis Recognition

- ▶ **Thyroid storm:** propylthiouracil + propranolol + cooling, NEVER aspirin (displaces T4)
- ▶ **Addisonian crisis:** IV hydrocortisone + NS + D5W STAT
- ▶ **Myxedema coma:** IV levothyroxine + warming + ventilation support

Medication Safety

- ▶ **Never** abruptly stop steroids — taper to prevent adrenal crisis
- ▶ **Stress-dose** steroids during illness, trauma, surgery
- ▶ **Lifelong** replacement therapy education for hypofunction states

7 Pharmacology — High-Yield Drugs

Drug / Class	Mechanism	Side Effects	Nursing Considerations
Levothyroxine (Synthroid) — T4 replacement	Synthetic T4 → ↑ metabolism	Tachycardia, weight loss, insomnia, tremor, signs of hyperthyroidism	AM, empty stomach, 30–60 min before breakfast; lifelong; assess HR before dose
PTU / Methimazole — Antithyroid	Blocks T3/T4 synthesis	Agranulocytosis (sore throat, fever), hepatotoxicity, rash	Report sore throat/fever; monitor CBC, LFTs; PTU preferred in 1st trimester pregnancy
Hydrocortisone / Prednisone — Glucocorticoids	Replace cortisol; anti-inflammatory	Hyperglycemia, HTN, ↑ infection, osteoporosis, GI ulcer, mood changes	NEVER stop abruptly — taper; take with food; stress-dose for illness; medical alert ID
Fludrocortisone — Mineralocorticoid	Replaces aldosterone (Na ⁺ retention, K ⁺ excretion)	Edema, HTN, hypokalemia, weight gain	Daily weights; monitor BP and K ⁺ ; used in Addison's
Desmopressin (DDAVP) — ADH analog	↑ water reabsorption in kidney	Hyponatremia, water intoxication, HA, seizures	Strict I&O; daily weight; monitor Na ⁺ ; given for DI & nocturnal enuresis
Tolvaptan / Conivaptan — Vaptans	ADH receptor antagonist	Thirst, dry mouth, rapid Na ⁺ correction	Used for SIADH; watch for too-fast Na ⁺ correction (osmotic demyelination)
Bromocriptine / Cabergoline — Dopamine agonists	↓ Prolactin secretion	N/V, orthostatic hypotension, HA	Used for prolactinoma; rise slowly; take with food
Octreotide — Somatostatin analog	↓ GH, GI hormones	Gallstones, diarrhea, hyperglycemia	Used for acromegaly; monitor glucose & gallbladder

Drug / Class	Mechanism	Side Effects	Nursing Considerations
Somatropin — GH replacement	Recombinant GH	Edema, joint pain, ↑ glucose, intracranial HTN	SQ injection; rotate sites; pediatric growth charts

8

! NCLEX Test Traps

TRAP #1 — TSH direction

In **primary HYPO**thyroidism, TSH is **HIGH** (not low). The pituitary is screaming at a broken thyroid. Low TSH + low T4 = *secondary* (pituitary) problem.

TRAP #2 — DI vs SIADH

"DI = Dilute & Dehydrated"; "SIADH = Soaked & Salt-low." Don't confuse polyuria of DI with diuresis of overload.

TRAP #3 — Cushing's K⁺

Cushing's = **HYPO**kalemia (cortisol mimics aldosterone, dumps K⁺). Addison's = **HYPER**kalemia. Students reverse these constantly.

TRAP #4 — Steroid taper

Never stop chronic steroids cold turkey — exogenous cortisol suppresses the HPA axis. Sudden withdrawal triggers *Addisonian crisis*.

TRAP #5 — Synthroid timing

Synthroid is taken **AM, empty stomach**. Don't pick "with food" or "at bedtime" — absorption is reduced and insomnia worsens.

TRAP #6 — Aspirin in thyroid storm

NEVER give aspirin in thyroid storm — it displaces T4 from binding proteins and worsens the storm. Use acetaminophen.

TRAP #7 — Stress-dose steroids

A patient on chronic prednisone going to surgery needs an **increased** dose, not a held dose. The body can't make more on its own.

TRAP #8 — DDAVP overcorrection

Too much DDAVP causes **dilutional hyponatremia** & seizures. Daily weight + Na⁺ monitoring is the priority.

9 Patient & Family Education

Lifelong replacement

- ▶ "This medication replaces what your body can no longer make — you'll take it for life."
- ▶ Never skip or stop suddenly
- ▶ Do not switch brands without HCP approval (esp. Synthroid)

Medical alert ID

- ▶ Required for: Addison's, panhypopituitarism, DI, post-adrenalectomy
- ▶ List medications and condition
- ▶ Carry emergency injectable hydrocortisone if prescribed

Sick-day rules

- ▶ Steroid dependence: **double or triple** dose during illness/fever/surgery
- ▶ Call HCP for vomiting (can't keep oral steroids down → injection needed)
- ▶ DM patients: never skip insulin even when not eating

Recognize warning signs

- ▶ Hypothyroid → *too tired to wake up*, weight gain → call HCP
- ▶ Hyperthyroid → palpitations, weight loss, heat intolerance
- ▶ Adrenal crisis → severe weakness, hypotension, vomiting → ER

Diet & lifestyle

- ▶ Cushing's: low Na, high K, high Ca/protein, limit sweets
- ▶ Addison's: liberal Na intake, especially in heat
- ▶ SIADH: fluid restriction (often 1000 mL/day)
- ▶ DI: free water access at all times

Follow-up labs

- ▶ Thyroid: TSH every 6–8 weeks until stable, then annually
- ▶ Adrenal: morning cortisol, electrolytes
- ▶ DM: A1C every 3 months

10 NCJMM Clinical Judgment Framework

1. Recognize Cues

Identify hyper- vs hypo-pattern: HR, weight, temp tolerance, skin, K⁺/Na⁺/glucose, urine output.

2. Analyze Cues

Group findings: "↓ HR + cold + weight gain + ↑ TSH" = primary hypothyroidism. "Polyuria + ↑ Na⁺ + dilute urine" = DI.

3. Prioritize Hypotheses

Crisis vs chronic: thyroid storm, myxedema coma, Addisonian crisis, severe SIADH (Na⁺ < 120) jump to top of the list.

4. Generate Solutions

Match hypothesis to action: replace what's missing, block what's excess, restore fluid/electrolyte balance, treat crisis with IV access + meds.

5. Take Action

ABCs first → IV access → labs → medications (steroids, levothyroxine, DDAVP, antithyroids) → strict I&O + monitoring.

6. Evaluate Outcomes

Reassess HR, BP, temp, LOC, Na⁺, K⁺, glucose, daily weight, urine SG. Education readiness for lifelong therapy.

11 Memory Boosters & Mnemonics

FLAT PiG

Anterior pituitary hormones: FSH, LH, ACTH, TSH, Prolactin, iGF/GH

"OUT the back"

Posterior pituitary stores: ADH and Oxytocin go OUT (released) the BACK (posterior).

DI = Dilute & Dehydrated • SIADH = Soaked & Salt-low

Pattern recognition for ADH disorders. DI dumps water; SIADH hoards it.

"Cushing's: Sweet, Salty, Swollen, Striped, Sick"

↑ Sugar (hyperglycemia), ↑ Salt (Na^+ retention/HTN), ↑ Swelling (truncal obesity, moon face), purple Stripes (striae), Sick (immune suppression).

"Addison's: Add some Sodium & Sugar"

Addison's = LOW Na^+ , LOW glucose, HIGH K^+ . Replace what's lost.

Thyroid: "Hyper = Hot, Hungry, Hyper-everything"

Hyperthyroid speeds everything up. Hypothyroid slows everything down.

Negative feedback = thermostat

High hormone tells the brain to STOP, just like a hot room turns off the heater.

"Primary = gland, Secondary = pituitary, Tertiary = hypothalamus"

Trace the broken link in the chain to classify any endocrine disorder.

Diane's NGN NCLEX 2026 Study Series

Endocrine Hormone Pathways • Visual Study Library • For educational use