The University of Burdwan
Three year UG course in Zoology under CBCS
DSE-4 (Endocrinology)

Neurosecretions and Neurohormones

DR. SAGAR ADHURYA

ASSISTANT PROFESSOR IN ZOOLOGY
WEST BENGAL EDUCATION SERVICE

Introduction

Neuroendocrine system = Nervous system + Endocrine system

What is the Neuroendocrine System?

- The **neuroendocrine system** represents a functional link between the **nervous system** and the **endocrine system**.
- It ensures the **coordination** and **regulation** of various physiological activities, particularly those requiring **long-term control**, such as growth, metabolism, reproduction, and homeostasis.

What Are Neurosecretions?

- Neurosecretions are **chemical substances** secreted by specialized **neurosecretory cells** (a type of neuron).
- Unlike typical neurons, which release neurotransmitters at synapses, neurosecretory cells release their products (called **neurohormones**) into the **bloodstream**.

Neurohormones

What Are Neurohormones?

- Neurohormones act **like hormones** but are **produced by neurons**.
- They regulate target organs **at a distance**, similar to classical endocrine hormones.
- Example: **Oxytocin**, **Vasopressin (ADH)**

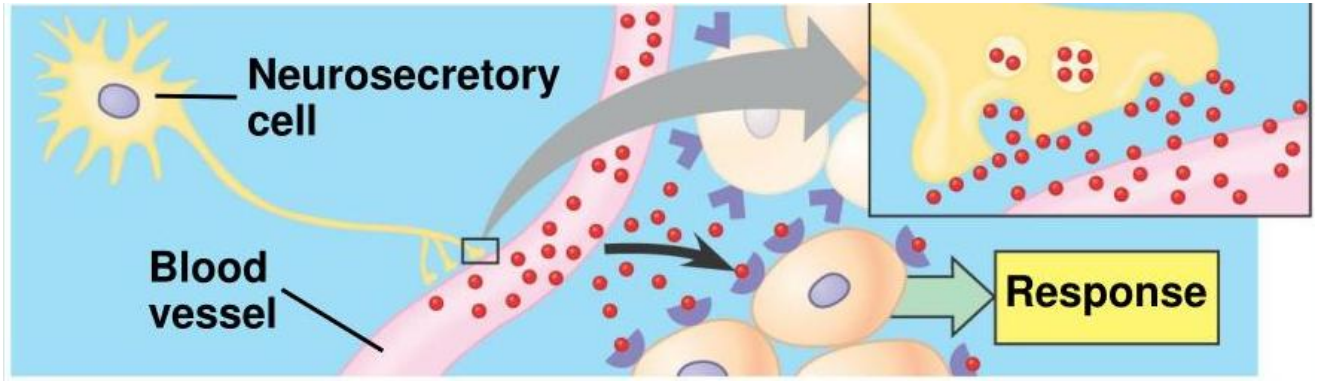
Why is it important?

- Neurosecretory mechanisms allow the nervous system to exert **systemic influence** over the body.
- This system is essential for:
  - **Synchronising internal physiology** with external environment
  - **Maintaining homeostasis**
  - **Mediating adaptive behaviours** like stress response and reproduction

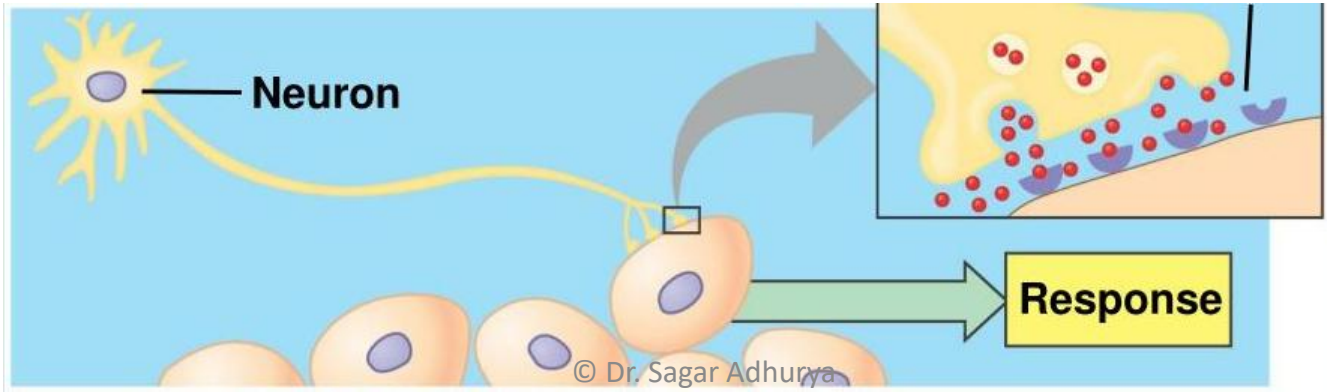
Neurotransmitter vs Neurohormones

Feature	Neurotransmitters	Neurohormones
Action	Synaptic	Distant
Duration	Short	Long
Transport	Synapse	Bloodstream

Neuroendocrine signalling



Synaptic signalling



Neurosecretory cells

- **Neurosecretory cells** are specialised neurons that synthesise and secrete **neurohormones** instead of neurotransmitters.
- These cells function as an **interface** between the nervous and endocrine systems.

Features of Neurosecretory Cells

- Structurally similar to typical neurons, but:
  - Possess a **large cell body** with prominent **Golgi bodies and endoplasmic reticulum**
  - Contain **secretory granules** with neurohormones
- Their axons transport secretions to a **release site** (e.g., median eminence, posterior pituitary)
- Secretion is **stimulated by nerve impulses**, but the release is **into blood**, not synaptic clefts

Location in vertebrates:

Hypothalamus, Neurohypophysis, adrenal medulla, penial gland, enteric nervous system

Hypothalamic Neurohormones

The hypothalamus produces **releasing** and **inhibiting** hormones that regulate the anterior pituitary gland or other target tissues.

- **Corticotropin-Releasing Hormone (CRH)**:
  - Function: Stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary, which regulates stress response and cortisol production.
  - Target: Anterior pituitary.
- **Gonadotropin-Releasing Hormone (GnRH)**:
  - Function: Stimulates the release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), controlling reproductive functions like gametogenesis and sex hormone production.
  - Target: Anterior pituitary.
- **Thyrotropin-Releasing Hormone (TRH)**:
  - Function: Stimulates the release of thyroid-stimulating hormone (TSH) and prolactin, influencing thyroid function and metabolism.
  - Target: Anterior pituitary.
- **Growth Hormone-Releasing Hormone (GHRH)**:
  - Function: Promotes the release of growth hormone (GH), which regulates growth and metabolism.
  - Target: Anterior pituitary.
- **Somatostatin (Growth Hormone-Inhibiting Hormone, GHIH)**:
  - Function: Inhibits the release of GH and TSH, modulating growth and metabolism.
  - Target: Anterior pituitary.
- **Dopamine (Prolactin-Inhibiting Hormone, PIH)**:
  - Function: Inhibits prolactin release, affecting lactation and reproductive functions.
  - Target: Anterior pituitary.

Hypothalamic Neurohormones

Hormone	Amino Acids	Hypothalamic Source	Physiological Actions on the Pituitary
Corticotropin-releasing hormone (CRH)	41	Parvoneurons of the paraventricular nuclei	Stimulates secretion of ACTH and β-lipotropin
Gonadotropin-releasing hormone (GnRH) (originally LHRH)	10	Arcuate nuclei	Stimulates secretion of FSH and LH
Growth hormone-releasing hormone (GHRH)	44	Arcuate nuclei	Stimulates GH secretion
Growth hormone releasing peptide (ghrelin)	28	Arcuate nuclei	Increases response to GHRH and may directly stimulate GH secretion
Somatotropin release-inhibiting factor (SRIF) / Somatostatin (SST)	14 or 28	Anterior hypothalamic periventricular system	Inhibits secretion of GH
Prolactin-stimulating factor (?)	?	?	Stimulates prolactin secretion (?)
Prolactin inhibiting factor (PIF) (Dopamine)	—	Tuberohypophyseal neurons	Inhibits prolactin secretion
Thyrotropin-releasing hormone (TRH)	3	Parvoneurons of the paraventricular nuclei	Stimulates secretion of TSH and prolactin
Arginine vasopressin (AVP)	9	Parvoneurons of the paraventricular nuclei	Acts in concert with CRH to stimulate secretion of ACTH

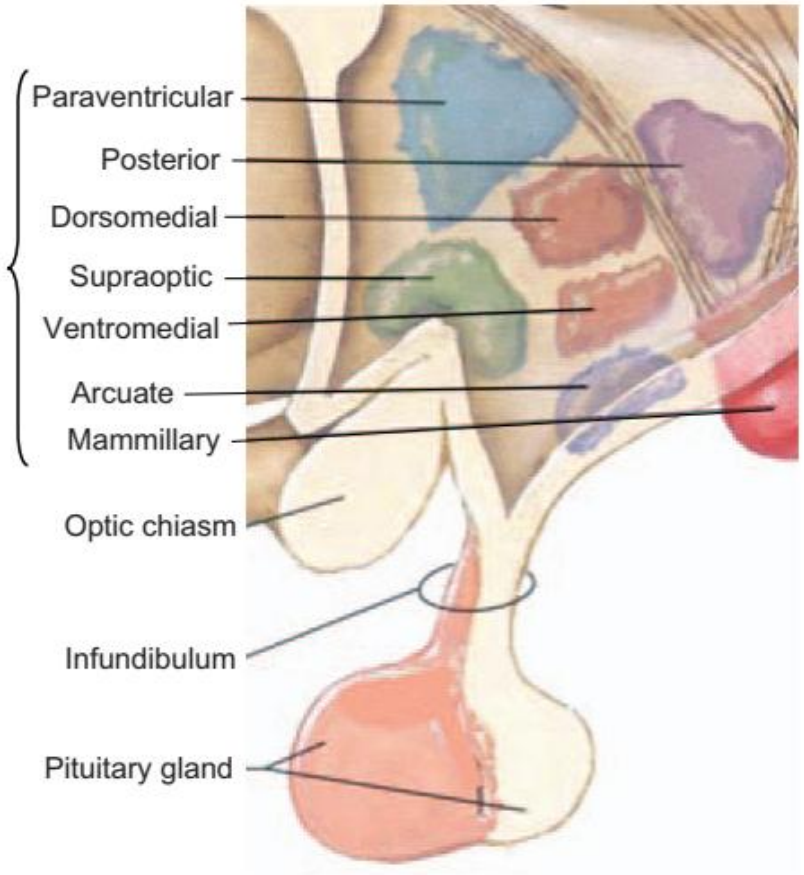
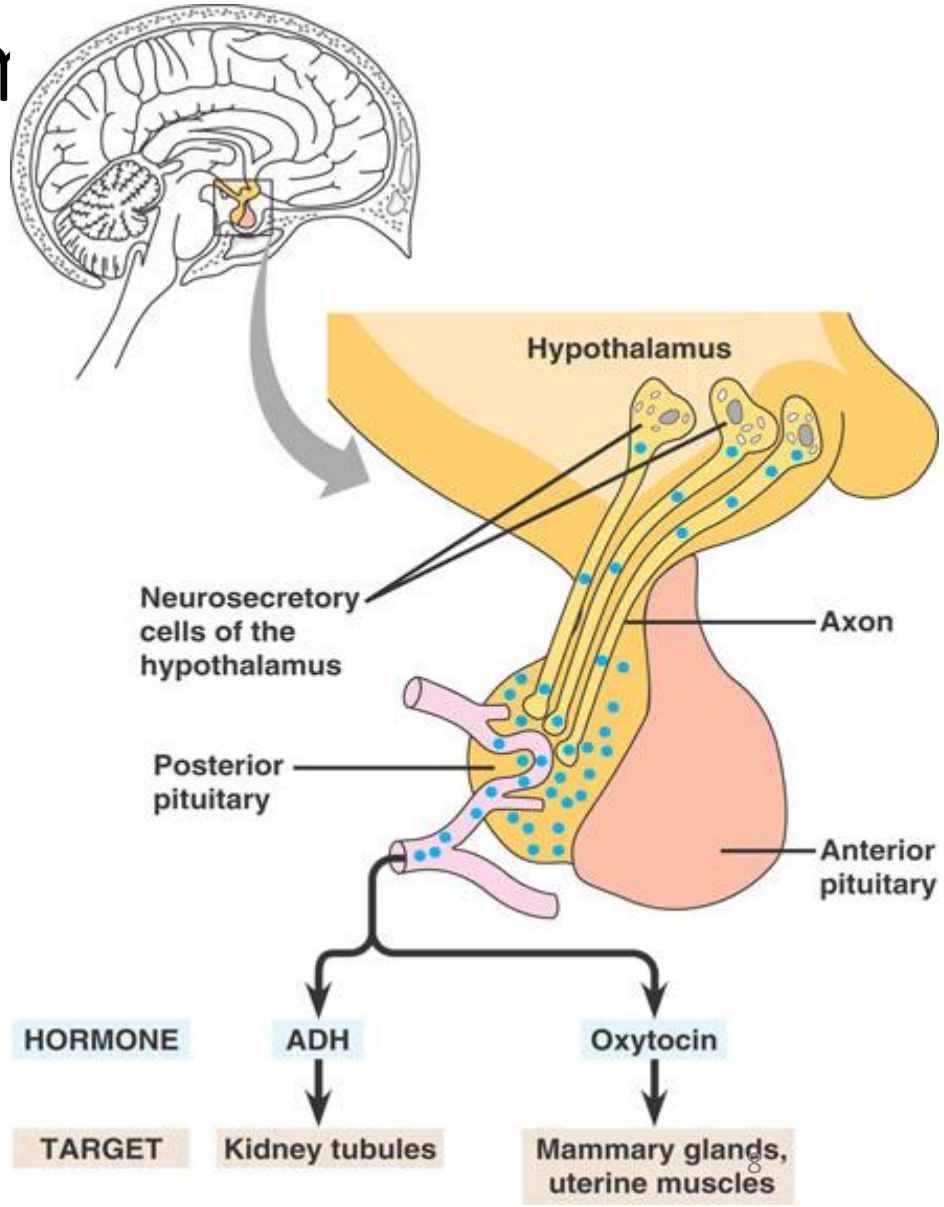


FIGURE 2.7 Mid-sagittal section of the human hypothalamus and pituitary. The principal nuclei of the hypothalamus are listed within the bracket. (From Netter, F.H. (1989) *Atlas of Human Anatomy*, 2nd ed. Novartis Summit New Jersey, Icon Learning Systems, LLC, a subsidiary of MediMedia, Inc. Reprinted with permission from Icon Learning Systems, LLC, illustrated by Frank H. Netter, MD. All rights reserved.)

Posterior Pituitary Neurohormones or Neurohypophyseal Neurohorm

These are synthesized in the hypothalamus but stored and released from the posterior pituitary.

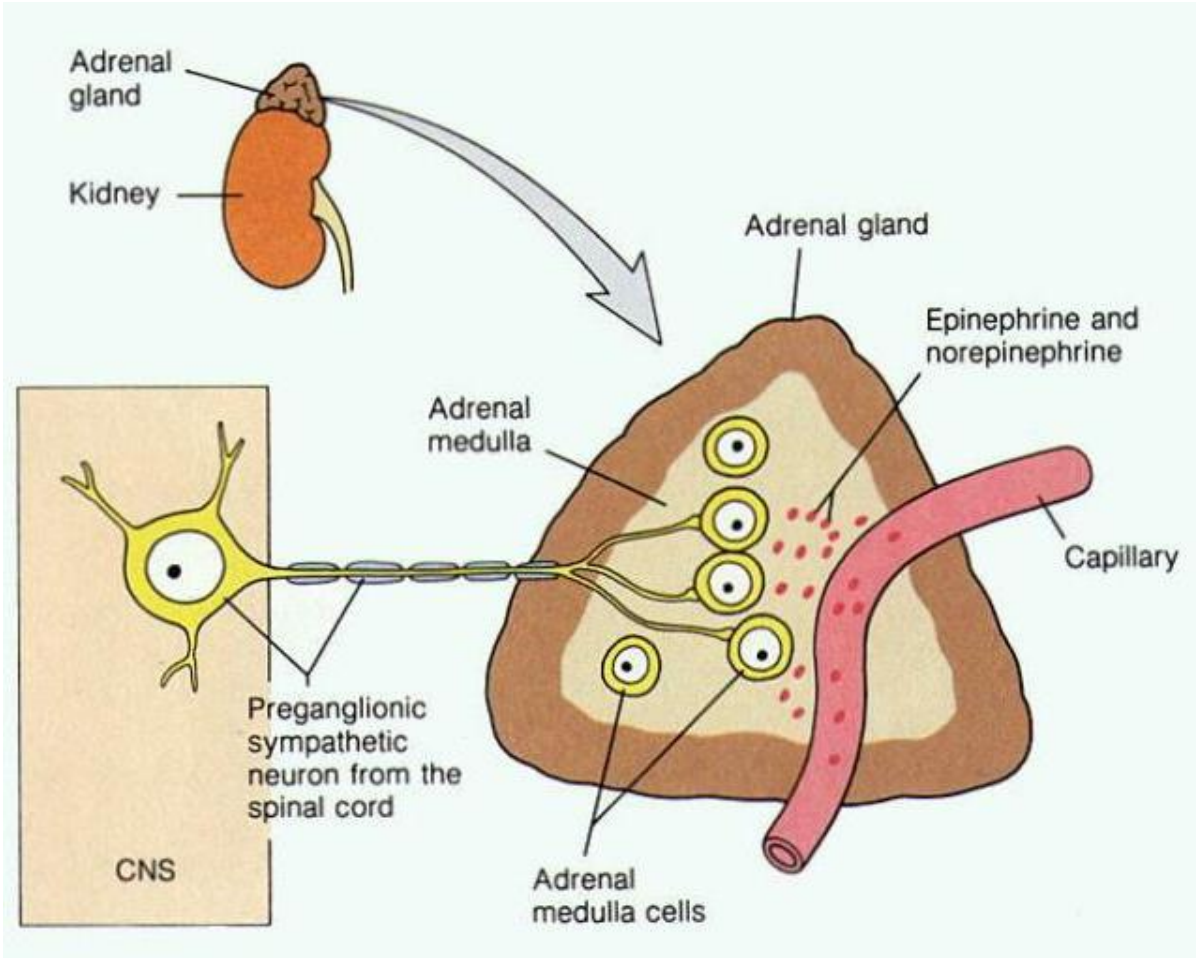
- **Oxytocin**:
  - Function: Regulates labor (uterine contractions), lactation (milk ejection), and social bonding behaviors.
  - Target: Uterus, mammary glands, and brain (behavioral effects).
- **Vasopressin (Antidiuretic Hormone, ADH)**:
  - Function: Controls water reabsorption in kidneys, regulates blood pressure, and influences social behaviors.
  - Target: Kidneys (collecting ducts), blood vessels.



Adrenal Medulla Neurohormones

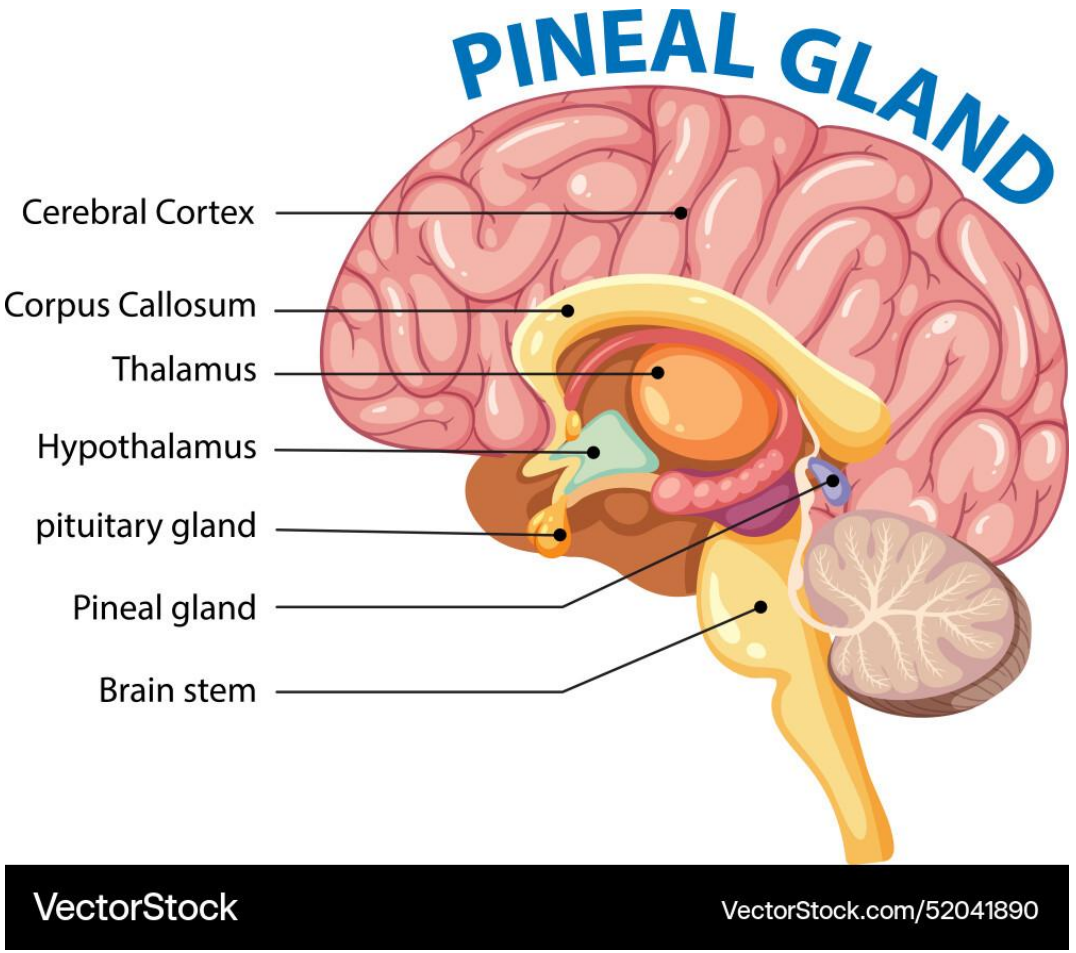
The adrenal medulla, part of the adrenal gland, secretes catecholamines that function as both neurotransmitters and neurohormones.

- **Epinephrine (Adrenaline)**:
  - *Function:* Triggers "fight or flight" responses, increasing heart rate, blood glucose, and metabolism during stress.
  - *Target:* Heart, liver, muscles, and other tissues.
- **Norepinephrine (Noradrenaline)**:
  - *Function:* Enhances vasoconstriction, increases blood pressure, and supports stress responses.
  - *Target:* Blood vessels, heart, and brain.



Pineal Gland Neurohormone

- **Melatonin**: Function: Regulates circadian rhythms, sleep-wake cycles, and seasonal reproductive behaviours.
- Target: Brain (suprachiasmatic nucleus), reproductive organs.



Neurohormones from Enteric Nervous system

Neurohormone	Origin	Functions	Target Organs
Neuropeptide Y (NPY)	Hypothalamus, sympathetic/enteric neurons	Appetite, energy balance, stress, cardiovascular	Brain, adipose tissue, heart, blood vessels
Vasoactive Intestinal Peptide (VIP)	Hypothalamus, pituitary, enteric/autonomic neurons	GI motility, vasodilation, immune response	GI tract, blood vessels, lungs, immune cells
Endorphins/Enkephalins	Pituitary, hypothalamus, spinal cord, peripheral neurons	Pain modulation, stress response, mood	Brain, spinal cord, peripheral tissues
Serotonin (5-HT)	Enterochromaffin cells, brainstem, pineal	GI motility, mood, sleep, cardiovascular	GI tract, brain, blood vessels, heart
Substance P	Sensory neurons, hypothalamus, enteric neurons	Pain, inflammation, immune response, GI motility	Brain, spinal cord, skin, blood vessels, GI
Somatostatin	Hypothalamus, pancreas, GI tract	Inhibits hormone release, regulates GI/pancreas	Pituitary, pancreas, GI tract, liver

Neurohaemal organs

- Structures where neuroendocrine cells release neurohormones into the bloodstream.
- Link nervous and endocrine systems.
- Vascularized for systemic hormone distribution.
- **Examples**:
  - **Vertebrates**:
    - *Posterior Pituitary:* Releases oxytocin, vasopressin.
    - *Median Eminence:* Neurohormones (e.g., GnRH, TRH) released into hypophyseal portal circulation to regulate anterior pituitary.
  - **Invertebrates:**
    - *Corpora Cardiaca:* Stores and releases hormones like adipokinetic hormone (AKH).
    - *Corpora Allata:* Secretes juvenile hormone, under neural regulation.

Neurosecretions in Invertebrates

Organism Group	Neuroendocrine Structures	Key Neurohormones	Functions
Insects	- Cerebral Neurosecretory Cells	Prothoracicotropic Hormone (PTTH)	Stimulates ecdysone secretion from prothoracic glands
	- Corpora Cardiaca (CC)	Adipokinetic Hormone (AKH), PTTH	Mobilises energy, regulates heart rate, releases stored neurohormones
	- Corpora Allata (CA)	Juvenile Hormone (JH)	Controls metamorphosis, reproduction, and development
	- Prothoracic Glands	Ecdysone	Triggers molting and metamorphosis
Annelids	- Neurosecretory Cells in Brain	Neuropeptides (e.g., Reproductive hormones)	Regulate regeneration, growth, reproduction, osmoregulation
Molluscs	- Optic Glands, Cerebral Ganglia	Gonadotropin-like Hormones	Stimulate gonad development and spawning

Summary

- **Neurosecretions** are specialised secretions produced by neurosecretory cells—bridging the nervous and endocrine systems.
- **Neurohormones** are hormones released by neurosecretory cells into the bloodstream to act at distant targets.
- Major **neuroendocrine sources** in vertebrates include:
  - **Hypothalamus** (e.g., CRH, GnRH, TRH)
  - **Adrenal medulla** (e.g., adrenaline, noradrenaline)
  - **Pineal gland** (e.g., melatonin)
  - **Enteric nervous system** (e.g., serotonin, substance P)
- **Neurohemal organs** (e.g., median eminence, pars nervosa) serve as release sites for neurohormones.
- In **invertebrates**, neurosecretions regulate moulting, reproduction, and metabolism via structures like corpora cardiaca and corpora allata.
- Understanding neurohormones is vital in deciphering physiological regulation and neuroendocrine integration.