wjpmr, 2025, 11(1), 148-152

SJIF Impact Factor: 6.842

WORLD JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.wjpmr.com

Review Article

ISSN 2455-3301

WJPMR

OVERVIEW OF THE ENDOCRINE SYSTEM: FUNCTIONS, GLANDS, AND THEIR HORMONAL REGULATION

[1]*Tejas R. Raut, [2]Aanand L. Deshmukh, [3]Gajanan M. Jawalkar and [4]Dr. Harigopal S. Sawarkar

[1-2]Student of B Pharma 4th Year,
[3]Associate Professor, Department of Quality of Assurance,
[4]Principal, Department of Pharmaceutical Chemistry,
Dr. Rajendra Gode College of Pharmacy, Amravati-444602, Maharashtra, India.

***Corresponding Author: Tejas R. Raut**

Student of B Pharma 4th Year, Dr. Rajendra Gode College of Pharmacy, Amravati-444602, Maharashtra, India.

Article Received on 02/10/2024 **Article Revised on 22/11/2024** **Article Accepted on 12/12/2024**

ABSTRACT

The endocrine system is a complex network of glands and organs responsible for producing, secreting, and regulating hormones in the body. These hormones act as chemical messengers that influence a wide range of physiological processes, including metabolism, growth, mood, reproduction, and immune function. Major endocrine glands include the pituitary, thyroid, adrenal, pancreas, and gonads (ovaries and testes), as well as specialized tissues such as the hypothalamus. The endocrine system operates in close interaction with the nervous system, maintaining homeostasis and responding to internal and external stimuli. Dysregulation of hormone levels can lead to a variety of disorders, ranging from diabetes and thyroid diseases to reproductive and metabolic disorders. Understanding the intricate functions of the endocrine system is crucial for diagnosing and treating these conditions.

KEYWORDS: Endocrine glands, endocrine system, hormones, chemical messengers.

INTRODUCTION

The endocrine system includes those organs of the body which produce hormones system comprises the bodily organs that generate hormones. It plays a role in mood as well as metabolism, growth and development, and tissue function.[1]

Endocrinology is the branch of medicine that helps in the treatment of endocrine gland diseases.

The endocrine system contains glands, which secretes a type of hormone directly into the blood to regulate the body.

The exocrine system uses ducts to secrete its chemicals, but the endocrine system does not. Although the endocrine system and the neurological system both use information signals, their mechanisms are different.

Endocrine glands and the hormones they secrete

❖ **Nervous system**

A. Hypothalamus

a) Thyrotropin-releasing hormone (TRH)
b) Gonadotropin-releasing hormone (GnRH)
c) Growth hormone releasing hormone (GHRH)
d) Vasopressin

B. Pineal body

C. Pituitary gland

a) Anterior pituitary lobe (adenohypophysis)
b) Posterior pituitary lobe (neurohypophysis)

D. Thyroid glands

a) Triiodothyronine (T3)
b) Thyroxine (T4)
c) Calcitonin Parafollicular cells

E. Parathyroid glands

a) Parathyroid hormone

F. Adrenal glands

a) Cortisol
b) Aldosterone
c) Adrenaline
d) Noradrenaline.

G. Reproductive system

- Male

a) Androgens (testosterone)

- Female

1. Ovarian follicle

a) Progesterone
b) Estrogens

2. Placenta
a) Human chorionic gonadotropin
b) Human placental lactogen

3. Uterus
a) Prolactin
b) Relaxin

❖ **Nervous system**
The body's primary regulatory, regulating, and communication system is the nervous system. All mental processes, including cognition, learning, and memory, are centered there.

Neuroglia serve as supporting cells.

A neuron consists of a single efferent process called an axon, one or more afferent processes called dendrites, and a cell body called a soma.

Located in the dorsal body cavity, the brain and spinal cord are the primary organs of the central nervous system.

The cranium, or skull, encloses the brain, while the vertebrae shield the spinal cord.

The cerebral cortex surrounds the brain is the outermost layer. It is composed of gray matter. The cortex divides into 4 lobes: frontal, parietal, occipital, and temporal, by different sulci.[2]

A. Hypothalamus
Heat regulation, appetite and fullness, circadian rhythms, sleep and exhaustion, memory and learning, arousal and reproductive cycling, blood pressure, and heart rate are all primarily regulated by the hypothalamus.

▪ **Some Hormones Released by Hypothalamus**

a) Thyrotropin-releasing hormone (TRH)
A hormone that the brain's hypothalamus produces. Its main job is to control the pituitary gland's production of thyroid-stimulating hormone (TSH).

b) Gonadotropin-releasing hormone (GnRH)
A hormone that releases by the hypothalamus.

c) Growth hormone releasing hormone (GHRH)
The pituitary gland releases additional growth hormone (GH) in response to a peptide hormone known as growth hormone-releasing hormone (GHRH). It is necessary to regulate growth, metabolism, and development.

d) Vasopressin
Vasopressin Antidiuretic hormone (ADH), another name for the peptide hormone vasopressin, is essential for controlling the body's water balance.

The hypothalamus generates it, while the posterior pituitary gland stores and releases it. Blood pressure and kidney reabsorption of water are both regulated by vasopressin.

B. Pineal gland
In humans and other mammals, the pineal gland is located in the centre of the brain which is the smallest gland of endocrine system produces sleep.

The pineal gland synthesizes melatonin from serotonin, a neurotransmitter, especially in response to darkness. Melatonin helps regulate the sleep-wake cycle, signaling the body to prepare for sleep when it gets dark and to wake up with daylight.

C. Pituitary Gland
Your pituitary gland's primary job is to create and release a number of hormones that support vital body processes, such as growth and metabolism.

a) Anterior pitutary
The anterior pituitary, also referred to as the adenohypophysis, is the front lobe of the pituitary gland. situated beneath the hypothalamus at the base of your brain. It regulates the activity of multiple other endocrine glands and is a component of your endocrine system.

i. Adrenocorticotropic hormone (ACTH)
The hypothalamus gland releases corticotropin-releasing hormone (CRH), which triggers the release of ACTH hormone. From the hypothalamus, the CRH would go to its portal system. It causes the proopiomelanocortin (POMC) to cleave into several molecules when it reaches the adenohypophysis. The three main ones are beta-endorphins, melanocyte-stimulating hormone (MSH), and ACTH. Through the bloodstream, ACTH stimulates the adrenal cortex and aids in increasing cortisol synthesis. Additionally, cortisol inhibits the release of CRH and ACTH by negative feedback.[3]

ii. Prolactin
Primarily, the hypothalamus regulates prolactin. The main hormone that suppresses prolactin release is dopamine. Lactating women's nipple stimulation sends afferent sensory nerve cell information to the brain, which reverses the feedback loop of prolactin inhibition. Dopamine release is blocked as a result of the sucking. Prolactin could then be released without interference. Prolactin aids in women's breast formation and growth as well as the maintenance of lactation.[4]

b) Posterior pituitary lobe (neurohypophysis)
Posterior lobe of the pituitary gland also known as the posterior pituitary, or neurohypophysis.

i. Oxytocin
Muscle contraction is brought on by oxytocin's direct impact on smooth muscle cells. It indirectly promotes PGF2 α production within the female vaginal tract. As a result, oxytocin plays a role in a variety of processes, including social, sexual, and maternal behaviour as well

as milk letdown, parturition, penile erection, and ejaculation.[5]

ii. Vasopressin

ADH mainly impacts the kidney's capacity to reabsorb water; when it is present, it increases water reabsorption via inducing the expression of water transport proteins in the collecting duct and late distal tubule. When the body reacts to the presence of ADH or loses control over its secretion, a number of disease conditions develop.[6]

D. Thyroid gland

One of the body's primary endocrine glands, the thyroid is located in front of the thyroid cartilage in the front triangle of the neck. Thyroxine (T4) and triiodothyronine (T3) are the two active thyroid hormones secreted by the thyroid gland.

THs play a significant part in the crucial stage of neuronal development. T3 influences the brain's cholinergic and seretonergic functions in addition to neurogenesis, synaptogenesis, migration, plasticity, and myelination. Thus, neurological and behavioural conditions, psychomotor symptoms, cognitive problems, and neurodegeneration are linked to thyroid dysfunction.

a) Triiodothyronine (T3)

Triiodothyronine (T3) is a thyroid hormone that plays a crucial role in regulating the body's metabolism. It is produced by the thyroid gland and is involved in controlling various physiological processes, including growth, development, temperature regulation, and energy production.

b) Thyroxine (T4)

T4 in the bloodstream to guarantee healthy foetal growth.[15,16]

Serum T3/T4 ratios are considerably elevated when iodine consumption is low, indicating a decrease in iodine atom abundance.[7]

E. Parathyroid gland

A variety of glands that release hormones into the bloodstream make up the endocrine system, which includes these glands. The parathyroid glands' primary job is to produce the parathyroid hormone (PTH).

a) Parathyroid Hormone

The polypeptide parathyroid hormone (PTH) is released by the parathyroid gland in response to low blood calcium levels. PTH helps the kidneys produce calcitriol (1,25-dihydroxycholecalciferol) and active vitamin D. The kidneys, small intestines, and bones are all affected by PTH. The parathyroid gland secretes more PTH as serum calcium levels fall. A negative feedback loop caused by elevated serum calcium levels instructs the parathyroid glands to stop generating PTH. The body's PTH process is complex, and abnormalities can have serious clinical repercussions. Knowledge of PTH is extremely relevant and significant.[8][9][10][11]

F. Adrenal glands

a) Cortisol

The steroid hormone cortisol is produced from cholesterol. The zona fasciculata layer of the adrenal cortex is where it is synthesized. The anterior pituitary releases adrenocorticotropic hormone (ACTH), which causes an increase in LDL receptors and the activity of cholesterol desmolase, the rate-limiting step in the synthesis of cortisol that converts cholesterol to pregnenolone.[12]

b) Aldosterone

The adrenal cortex's zona glomerulosa is the primary location for aldosterone synthesis and secretion. A number of cues, such as renin-angiotensin system activation, influence aldosterone production and release in physiological contexts.[13-17]

c) Adrenaline

It is a hormone which helps the body in flight and fight conditions.

d) Noradrenaline

It is a hormone which secreted in the body after adrenaline to bring the body in normal condition.

G. Reproductive system

- **Male**

a) Testosterone:- Testicular descent, spermatogenesis, and penile enlargement are all aspects of primary sexual development that are triggered by testosterone.[18]

- **Female**

1. Ovarian Follicle

a) Progesterone

During pregnancy, progesterone is essential for uterine environmental preservation. Therefore, the loss of this steroid hormone is a significant concern as it is linked to preterm labour and miscarriage. One of progesterone's main roles during pregnancy is to keep the myometrium's vascular tone at a lower level. Additionally, progesterone affects how human T-cells and other inflammatory mediators are produced inside the uterus. Progesterone deficiency, then, causes myometrial contractility to increase and immune defences to deteriorate, which raises the chance of miscarriage and premature foetal birth.[19]

b) Oestrogens

Female sexual features are developed by the steroid hormone oestrogen, which is linked to the female reproductive organs. Oestrone, oestradiol, and oestriol are common names for oestrogen. Oestradiol is the most widely used form of oestrogen hormone for hormone replacement therapy (HRT) to treat menopausal symptoms.[20]

Early research suggests that oestrogen, when used as a hormone replacement treatment for postmenopausal

women, may reduce their risk of osteoporosis, coronary artery disease, and death.Subsequent research by the Women's Health Initiative found that for postmenopausal women, the risk outweighed the advantages of hormone replacement treatment.

Because research participants had an elevated risk of coronary artery disease and breast cancer, the Women's Health Initiative terminated clinical trials early.[21]

2. Placenta

The umbilical cord is a tube-like structure that connects the placenta to a developing foetus. A developing newborn receives oxygen and nutrients from the placenta through the umbilical chord.

a) Human chronic gonadotropin

During pregnancy, human chorionic gonadotrophin (HCG) hormone is produced by the placenta. Because of its special function in pregnancy, referred to as the pregnancy hormone. About 10 to 11 days after conception—the process by which a sperm fertilizes an egg—HCG is detected in your blood or urine. Towards the end of the first trimester (10 weeks of pregnancy), your HCG levels are at their peak, and they subsequently start to drop for the remainder of your pregnancy. In order to verify a pregnancy and give information on the status of the pregnancy, medical professionals measure HCG.

How it is produced?

A fertilized egg passes through your fallopian tubes and into your uterus after conception. The fertilized egg, also known as an embryo, implants, or adheres, to the uterine wall. The placenta forms as a result of this. HCG is produced by your placenta and released into your blood and urine. About eleven days after conception, a person's blood contains HCG. On urine tests, HCG takes a little longer to register.

HCG rises rapidly throughout the first eight to ten weeks of pregnancy, nearly doubling every three days. In order to assess the development of the pregnancy and foetus medical professionals look at how quickly a person's HCG levels grow in the early stages of pregnancy.

What does human chronic gonadotropin do?

When your placenta starts producing HCG, your body starts producing more progesterone and estrogen. These hormones work in tandem with HCG to thicken the lining of your uterus and instruct your body to cease menstruation (or egg release). The proper balance of these three hormones maintains and promotes the pregnancy.

b) Human placental lactogen

The placenta produces and secretes a protein hormone called PLACENTAL lactogen (PL), which shares remarkable chemical and biological characteristics with growth hormone [GH] and prolactin hormone [PRL].

3. Uterus:- The uterus is a muscular, hollow organ which is situated between the rectum and bladder in the female pelvis. The eggs are produced in the ovaries. The egg can be fertilized and implanted in the uterine lining after it has departed from the ovary. The uterus' primary job is to provide nutrition to the growing foetus prior to it is born.

a) Prolactin

Prolactin Lactation, breast development, and hundreds of other homeostasis-maintaining processes are all regulated by the polypeptide hormone prolactin.

b) Relaxin

Relaxin has significant positive effects to the endometrium, for the relaxation of the cardiovascular tissues as well as the which needed the help during parturition which is in responsible for building of pregnancy.

CONCLUSIONS

The endocrine system plays a vital role in maintaining the body's internal balance and regulating numerous physiological processes. Through the secretion of hormones, it coordinates critical functions such as metabolism, growth, reproduction, and stress responses. The seamless interaction between the endocrine and nervous systems ensures proper homeostasis, allowing the body to adapt to various environmental and internal changes. Disruptions in endocrine function can lead to a range of health issues, underscoring the importance of understanding its mechanisms. Continued research into the endocrine system is essential for advancing treatments for endocrine-related disorders and improving overall health outcomes.

REFERENCES

1. Collier, J.A.B., Collier, J., Longmore, M., Longmore, J.M. and Amarakone, K., 2013. *Oxford handbook of clinical specialties*. Oxford University Press, USA.
2. Shipp, S., Structure and function of the cerebral cortex. *Current Biology*, 2007; *17*(12): R443-R449.
3. Allen, M.J. and Sharma, S., 2018. Physiology, adrenocorticotropic hormone (ACTH).
4. Sharma, S., Hashmi, M.F. and Chakraborty, R.K., 2021. StatPearls [Internet] StatPearls Publishing. *Treasure Island (FL), Sep*, *18*.
5. Assad, N.I., Pandey, A.K. and Sharma, L.M., Oxytocin, functions, uses and abuses: a brief review. Theriogenology Insight-An International Journal of Reproduction in all Animals, 2016; 6(1): 1-17.
6. Cuzzo, B., Padala, S.A. and Lappin, S.L., Physiology, vasopressin. In *StatPearls [Internet]*. StatPearls Publishing, 2023.
7. De Escobar, G.M., Ares, S., Berbel, P., Obregón, M.J. and del Rey, F.E., December. The changing role of maternal thyroid hormone in fetal brain development. In *Seminars in perinatology*, 2008; 32(6): 380-386. WB Saunders.

8. Rudin AV, McKenzie TJ, Wermer RA, Thompson GB, Lyden ML. Primary Hyperparathyroidism: Redefining Cure. Am Surg, Feb. 01, 2019; 85(2): 214-218. [PubMed] [Reference list]
9. Sharma S, Hashmi MF, Castro D. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL), Dec. 26, 2022. Hypophosphatemia. [PubMed] [Reference list]
10. Byrd C, Kashyap S, Kwartowitz G. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL), Jul 24, 2023. Parathyroid Cancer. [PMC free article] [PubMed] [Reference list]
11. Lofrese JJ, Basit H, Lappin SL. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL), Jul 17, 2023. Physiology, Parathyroid. [PubMed] [Reference list]
12. Angelousi A, Margioris AN, Tsatsanis C. ACTH Action on the Adrenals. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, de Herder WW, Dhatariya K, Dungan K, Hofland J, Kalra S, Kaltsas G, Kapoor N, Koch C, Kopp P, Korbonits M, Kovacs CS, Kuohung W, Laferrère B, Levy M, McGee EA, McLachlan R, New M, Purnell J, Sahay R, Shah AS, Singer F, Sperling MA, Stratakis CA, Trence DL, Wilson DP, editors. Endotext [Internet]. MDText.com, Inc.; South Dartmouth (MA), Jun 13, 2020. [PubMed] [Reference list]
13. Biron P, Koiw E, Nowaczynski W, Brouillet J, Genest J. The effects of intravenous infusions of valine-5 angiotensin II and other pressor agents on urinary electrolytes and corticosteroids, including aldosterone. J Clin Invest, 1961; 40: 338–347. [DOI] [PMC free article] [PubMed] [Google Scholar]
14. Carpenter CC, Davis JO, Ayers CR. Relation of renin, angiotensin II, and experimental renal hypertension to aldosterone secretion. J Clin Invest, 1961; 40: 2026–2042. [DOI] [PMC free article] [PubMed] [Google Scholar]
15. Synthase in human vascular endothelial cells by angiotensin II and adrenocorticotropin. J Clin Endocrinol Metab., 1996; 81: 2797–2800. [DOI] [PubMed] [Google Scholar]
16. Davis JO, Carpenter CC, Ayers CR, Holman JE, Bahn RC. Evidence for secretion of an aldosterone-stimulating hormone by the kidney. J Clin Invest, 1961; 40: 684–696. [DOI] [PMC free article] [PubMed] [Google Scholar]
17. Mulrow PJ, Ganong WF. Stimulation of aldosterone secretion by angiotensisn. II. A preliminary report. Yale J Biol Med., 1961; 33: 386–395. [PMC free article] [PubMed] [Google Scholar]
18. Kalfa N, Gaspari L, Ollivier M, Philibert P, Bergougnoux A, Paris F, Sultan C. Molecular genetics of hypospadias and cryptorchidism recent developments. Clin Genet., Jan. 2019; 95(1): 122-131. [Abstract]
19. Arab H, Alharbi AJ, Oraif A, Sagr E, Al Madani H, Abduljabbar H, Bajouh OS, Faden Y, Sabr Y. The Role Of Progestogens In Threatened And Idiopathic Recurrent Miscarriage. Int J Womens Health., 2019; 11: 589-596. [PMC free article] [PubMed] [Reference list]
20. Lobo RA, Pickar JH, Stevenson JC, Mack WJ, Hodis HN. Back to the future: Hormone replacement therapy as part of a prevention strategy for women at the onset of menopause. Atherosclerosis, Nov. 2016; 254: 282-290. [PubMed] [Reference list]
21. Rossouw JE, Anderson GL, Prentice RL, LaCroix AZ, Kooperberg C, Stefanick ML, Jackson RD, Beresford SA, Howard BV, Johnson KC, Kotchen JM, Ockene J., Writing Group for the Women's Health Initiative Investigators. Risks and benefits of estrogen plus progestin in healthy postmenopausal women: principal results From the Women's Health Initiative randomized controlled trial. JAMA., Jul. 17, 2002; 288(3): 321-33. [PubMed] [Reference list]
22. Goldsmith LT, Weiss G, Palejwala S, Plant TM, Wojtczuk A, Cole D, Skurnick JH, Edwards D, Lambert WC, Ammur N. Relaxin Regulation of Endometrial Function in the Rhesus Monkey, PNAS (USA), 2004; 101: 4685–4689. doi: 10.1073/pnas.0400776101. [DOI] [PMC free article] [PubMed] [Google Scholar]