HYPOTHALAMUS

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HYPOTHALAMUS

- BELOW THALAMUS.
- CONTAINS VARIOUS NUCLEI:

1) ANTERIOR GROUP:
   ANTERIOR
   PREOPTIC
   PARAVENTRICULAR
   SUPRAOPTIC
   SUPRACHAISMATIC

2) MIDDLE GROUP:
   DORSOMEDIAL
   VENTROMEDIAL
   LATERAL
   TUBERAL

3) POSTERIOR GROUP
   POSTERIOR
   MAMILLARY

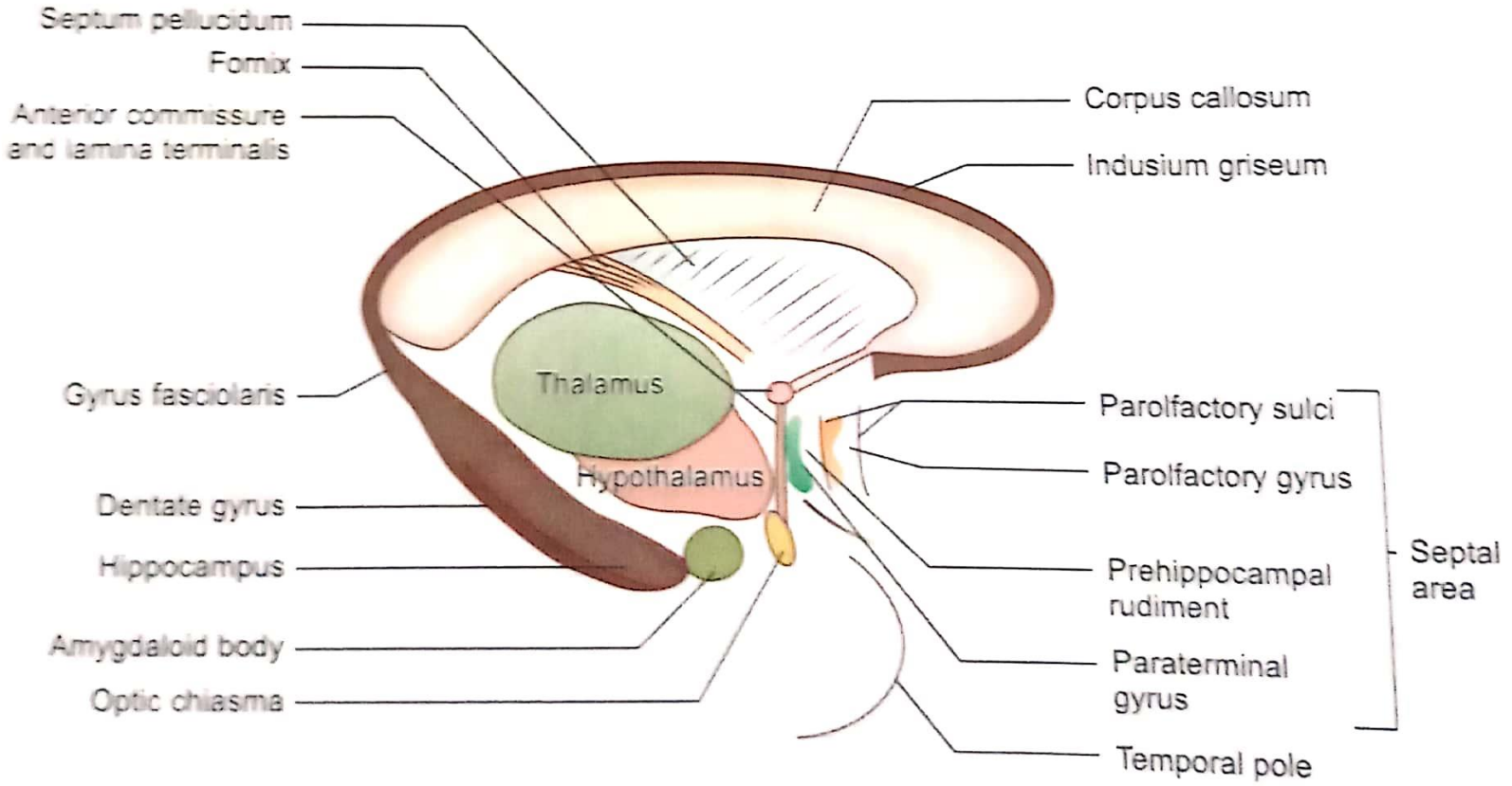


Fig. 108.1: Location of the hypothalamus in the brain.

CONNECTIONS

- AFFERENT: LIMBIC SYSTEM, FRONTAL CORTEX, BASAL GANGLIA, THALAMUS, RETICULAR FORMATION, RETINA

- EFFERENT: THALAMUS, MIDBRAIN, RETICULAR FORMATION, FRONTAL CORTEX, POSTERIOR PITUITARY

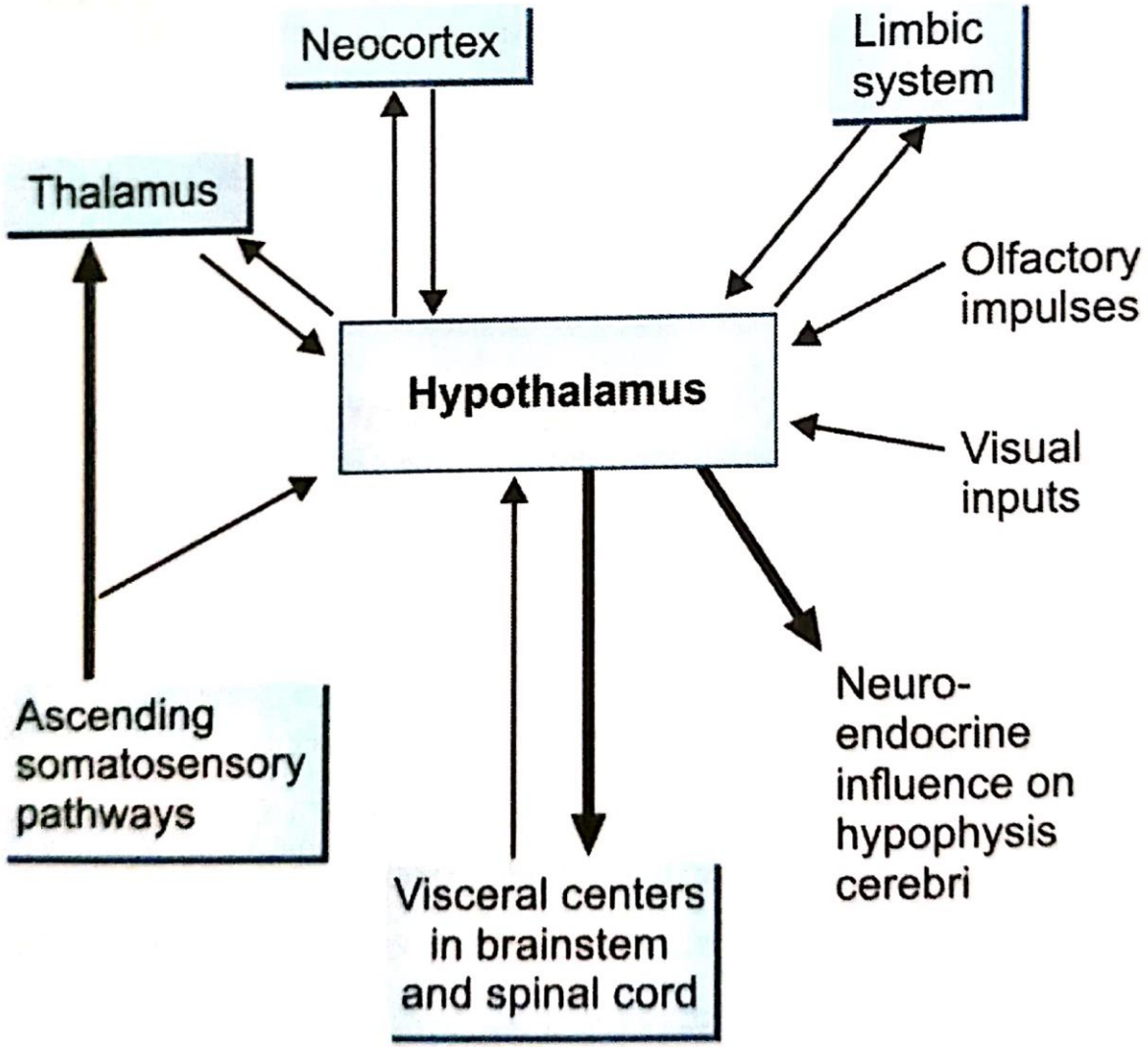


Fig. 108.2: Connection of hypothalamus with other brain centers. *Note*: after receiving inputs from all these structures, hypothalamus funnels these inputs to the brainstem and pituitary for regulation of visceral functions.

AFFERENT CONNECTIONS

1) From limbic system:

* Medial forebrain bundle: begins from anterior olfactory areas and end in hypothalamic nuclei. These fibres are related to emotional drives and sense of smell.

* Stria terminalis, Fornix

* Media corticohypothalamic tract

2) From midbrain: Adrenergic, nor adrenergic and serotonergic (regulate sleep wakeful cycle) fibers.

3) From retina: retinohypothalamic tract.

4) From thalamus: thalamohypothalamic tract

5) From basal ganglia: Pallidohypothalamic tract.

EFFERENT CONNECTIONS

1) To limbic system: Median forebrain bundle, stria terminalis.

2)To thalamus: Mammillothalamic tract.

3) To midbrain: Mamillotegmental tract

4)To posterior pituitary: Hypothalamo hypophyseal tract

5) To spinal cord:

extrapyramidal facilitatory pathway, sympathetic and parasympathetic regulation

FUNCTIONS

Vegetative

Endocrine functions

Behavioral functions

Nuclei of hypothalamus and their functions

Ante. Preoptic- heat loss (PO)/ parasympathetic/ osmoreceptors (near)

Posterior- heat gain/ sympathetic/

lateral- thirst/ hunger/ rage/ sympathetic/ reward

Ventromedial- satiety/ placidity/ reward

Suprachiasmatic- circadian/ sleep

VEGETATIVE FUNCTIONS

REGULATION OF BODY TEMPERATURE

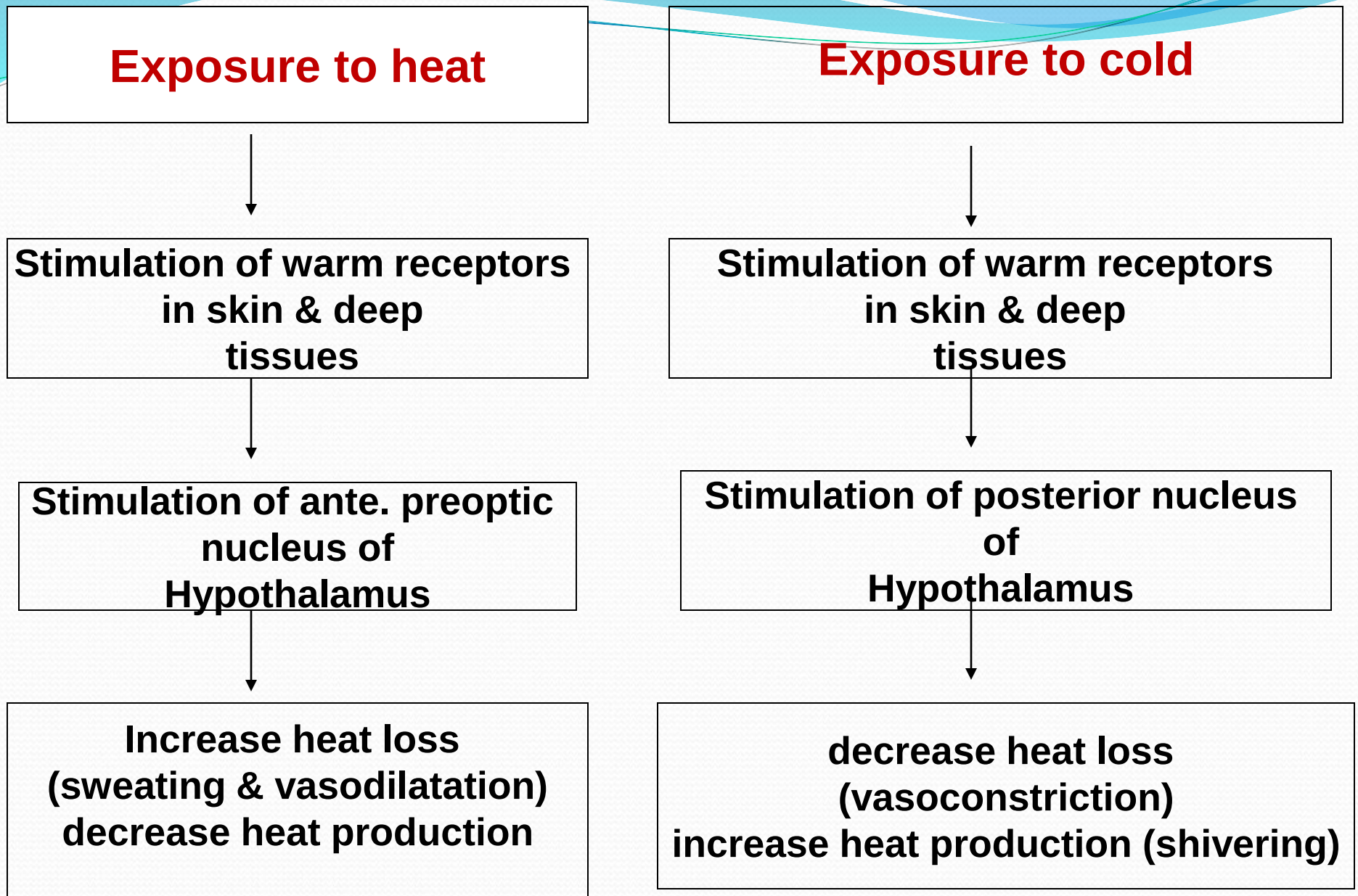
- Principal integrating centre for heat regulation.

1) Anterior preoptic nucleus- heat loss (sweating) center:

- Stimulation results in cutaneous vasodilatation, increased sweating, panting.

2) Posterior nucleus- heat gain (shivering) center:

- Stimulation causes cutaneous vasoconstriction and shivering.


Exposure to heat
Stimulation of warm receptors in skin & deep tissues
Stimulation of ante. preoptic nucleus of Hypothalamus
Increase heat loss (sweating & vasodilatation) decrease heat production
Exposure to cold
Stimulation of warm receptors in skin & deep tissues
Stimulation of posterior nucleus of Hypothalamus
decrease heat loss (vasoconstriction) increase heat production (shivering)

REGULATION OF BODY WATER OR PLASMA OSMOLARITY

* Lateral nucleus of hypothalamus- thirst center.

The main stimulus for thirst centre is increased plasma osmolality : intense desire for water .

* Osmoreceptors in supraoptic nucleus : controlling water loss.

Increased plasma osmolality - stimulates osmoreceptors in supraoptic nucleus- send impulses to posterior pituitary gland to secrete hormone ADH, increased reabsorption of water from collecting ducts of kidneys.

REGULATION OF BODY WEIGHT OR HUNGER

- Lateral nucleus – hunger/feeding center
- Ventromedial nucleus - satiety center
- The balanced activity of these two centres is responsible for normal food intake.

Theories or mechanisms of regulation of food intake

1) Glucostatic mechanism
2) Lipostatic mechanism (leptin from fat cells inhibites hunger)
3) Thermostatic mechanism (decrease body temp stimulates hunger)
4) Peptide & hormone mechanism (from gut & brain)

Theories or mechanisms of regulation of food intake

GLUCOSTATIC THEORY

- lateral hypothalamic area: hunger centre which is chronically active,creates a sensation of hunger. Cells function as glucoreceptors, also called as glucostats i.e. receptors which sense the glucose level in blood.
- ventromedial nucleus of hypothalamus: satiety centre which keep hunger center inhibited.
- Hypothalamic peptides increasing food intake are: neuropeptide Y, Orexin A, Orexin B, Ghrelin.
- decreasing food intake are: alpha MSH, CRH, CART (Cocaine and amphetamine regulated transcript).

LIPOSTATIC MECHANISM:

- Leptin (means thin) is a circulating protein hormone produced mainly in adipose cells. It acts on hypothalamus to decrease release of Neuropeptide Y and produces decreased food intake and increased metabolism. Any defect in leptin receptor gene results in obesity.

- **THERMOSTATIC MECHANISM:**

  Decrease body temp. stimulates hunger and vice versa.

- **GUT PEPTIDE THEORY:**

  Food in GIT causes release of GI hormones (CCK, glucagon, somatostatin), which act on hypothalamus to inhibit food intake.

REGULATION OF AUTONOMIC FUNCTIONS

Anterior part is – parasympathetic center.

- Stimulation of preoptic area (anterior), decreases heart rate and blood pressure, cutaneous vasodilatation, constriction of pupil, increases peristalsis and secretomotor functions of GIT (tropotrophic functions).

Posterior & lateral part is – sympathetic center.

- increase in heart rate and blood pressure, cutaneous vasoconstriction, dilatation of pupil, decreases the secretion and motility of GIT (ergotropic function).

REGULATION OF ENDOCRINE FUNCTION

CONTROL OF ANTERIOR PITUITARY GLAND

- hypothalamic releasing and inhibiting factors (GHRH, GHIH, TRH, CRH, GnRH, PIH).
- Control hormones of Anterior Pituitary gland.
- Thyroid gland, Adrenal cortex, testis and ovary are controlled by Hypothalamo hypophyseal portal system.

SECRETION OF POSTERIOR PITUITARY HORMONES

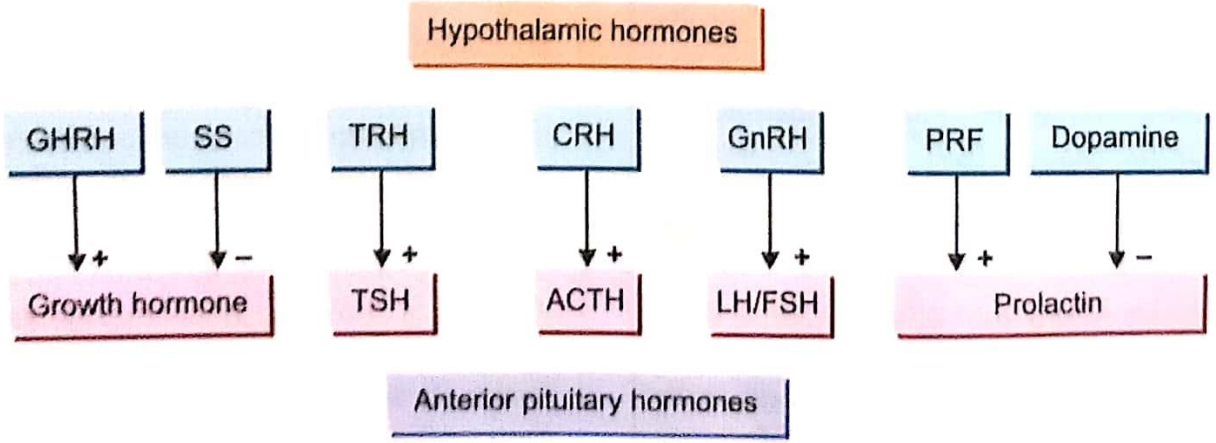
- ADH (by Supraoptic nucleus) and
  oxytocin (by paraventricular nucleus).
- ADH control body water & BP while oxytocin cause expulsion of fetus during parturition and milk ejection.

Scientists contributed

Roger Charles Louis Guillemin (Born, 1924) the **Nobel prize in Physiology and Medicine for the year 1977** for his work on **neurohormones** (peptide hormones produced in the brain), sharing the prize with **Andrew V Schally** (Born, 1926). Guillemin and Schally discovered the structures of TRH and GnRH in separate laboratories.

RC Louis Guillemin

Andrew V Schally

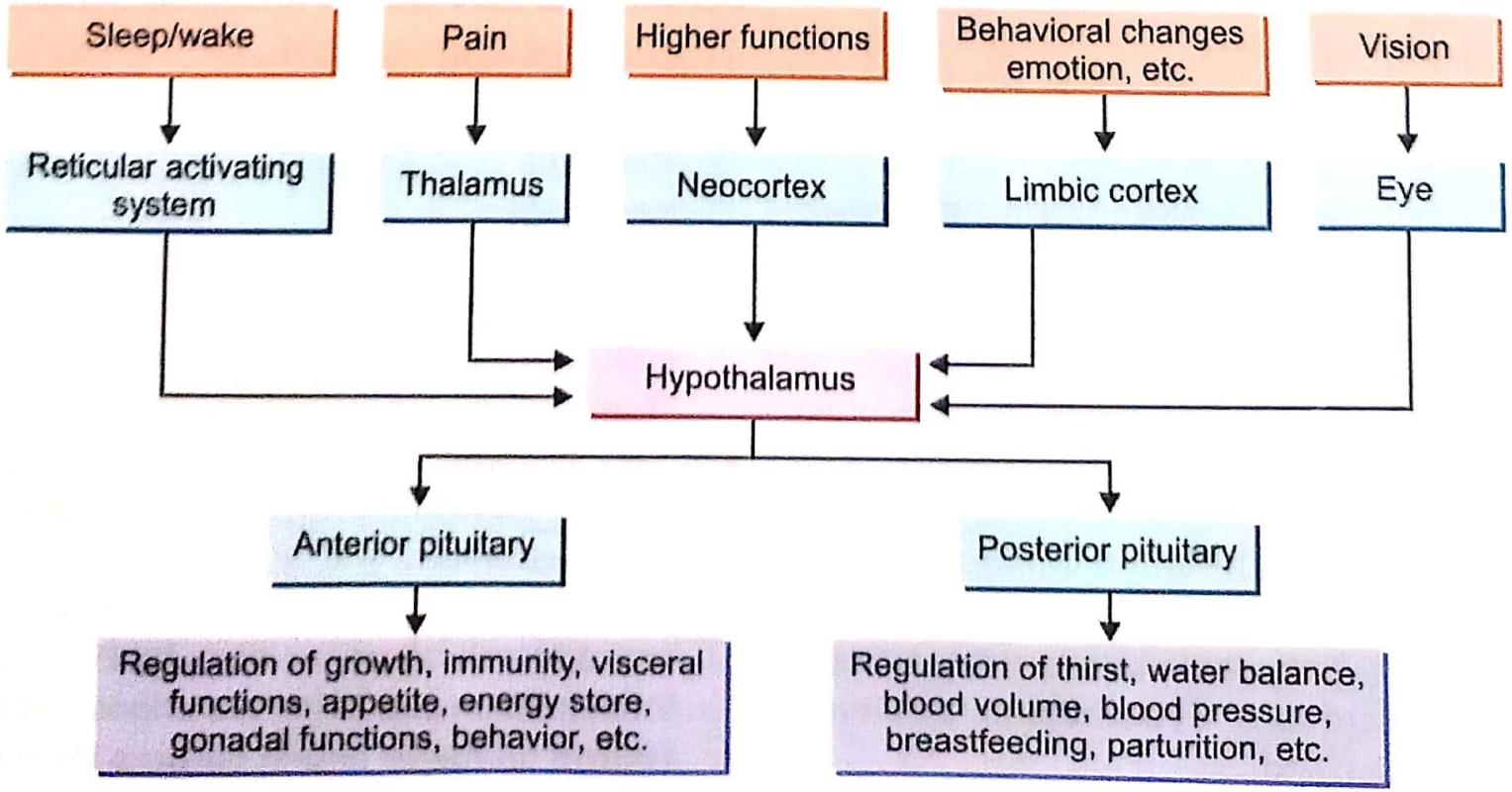


(ACTH: adrenocorticotropic hormone; CRH: corticotropin releasing hormone; FSH: follicular stimulating hormone; GHRH: growth hormone releasing hormone; GnRH: gonadotropin releasing hormone; LH: luteinizing hormone; PRF: prolactin releasing factor; SS: somatostatin; TRH: thyrotropin releasing hormone; Plus sign (+) indicates stimulation and minus sign (–) indicates inhibition)

REGULATION OF BEHAVIOUR AND EMOTIONS

- Head quarter of limbic system
- Behaviours like attack, laughing, crying or blushing
- Integrates endocrine, autonomic and some motor activities

Flowchart 108.1: Hypothalamic integration of neural and endocrine functions.



- Reward centers: lateral and ventro-medial nucleus: placidity and tameness.

- Punishment centers: medial hypothalamus (periventricular zone)-pain, fear, defense, escape reactions and other elements of punishment. Experimental animals avoid stimulation of this area.

RAGE: ANGER

- Normally, kept in check by counterbalancing activity of ventro medial nuclei of hypothalamus, limbic system
- Rage reaction : Excessive stimulation of punishment center: Development of defense posture, extension of limbs, lifting of tail, hissing and splitting, pilo erection, wide opening of eyes, dilation of pupils and severe savage attack even on mild provocation.

SHAM RAGE

- Calm state: due to, to and fro connections between hypothalamus and cerebral cortex.
- Cortex, normally tends to inhibit rage phenomenon. * When the connection between cerebral cortex and hypothalamus is severed, by decortication, experimental animal exhibits outburst of rage on mild peripheral stimulation.
- Sham rage: due to release of hypothalamus from cortical control.

Regulation of reproductive system

- Gonadotropin releasing hormone: secreted from neurons of pre optic area of hypothalamus
- GnRH begins at puberty and then continues throughout reproductive life.
- Essential for cyclical surge of gonadotropin before ovulation

CIRCADIAN RHYTHM

- Changes in levels of hormones or any other body function rhythmically throughout day: Diurnal variation , 24 hours. E.g. rhythm in secretion of hormones like ACTH, cortisol, GH etc., sleep waking cycle, body temperature rhythm.
- Suprachiasmatic N. (SCN) is also called as biological clock.
- Retinohypothalamic fibres
- Noctural secretion of melatonin
- DISTURBANCE: JET LAG

REGULATION OF SLEEP

- Anterior part (supra chiasmatic nucleus) of hypothalamus is sleep facilitatory center. Its stimulation induces sleep.

- Posterior hypothalamus acts as waking center, i.e. its stimulation leads to wakefulness.

ROLE IN IMMUNITY

- Hypothalamo-pituitary-adrenal axis
- CRH (HYPOTHALAMUS)
- ACTH (ANTERIOR PITUITARY)
- CORTISOL (ADRENAL CORTEX)
- STRESS HORMONE, DEPRESSES IMMUNITY

- **<u>Control of Adrenal medulla-</u>** DM nucleus stimulates adrenal medulla by sympathetic nerves in response to emotional stimuli

- Role in smell

APPLIED: LESIONS

- Tumors, inflammation (infection), ischemia, damage due to surgical operations.
- Anorexia Nervosa, Bulimia
- Autonomic disturbances: Arrythmias, hypertension
- Disturbances of body temperature regulation.
- Sleep disturbances.
- Endocrine abnormalities: Diabetes insipidus, SIADH, hypogonadism, hypothyroidism
- Disturbances in sexual functions.
- Disturbances in bady water balance: excessive thirst or polyuria.
- Emotional disturbances: Sham rage.

DISORDERS OF HYPOTHALAMUS

- DIABETES INSIPIDUS
- DYSTROPHIA ADIPOSOGENITALIS
- LAURENCE BIEDL MOON SYNDROME
- NARCOLEPSY
- CATAPLEXY

THANK YOU