Chapter 1: Hormones of the Hypothalamus


The hypothalamus lies below the thalamus in the walls and floor of the third ventricle. It is divided into medial and lateral groups by a curved bundle of axons called the fornix, which originate in the hippocampal formation and project to the mammillary body. The posterior portion of the hypothalamus, called the median eminence, contains the nerve endings of many neurosecretory cells, which run down through the infundibular stalk into the pituitary gland. Important structures adjacent to the median eminence of the hypothalamus include the mammillary bodies, the third ventricle, and the optic chiasm a part of the visual system. Above the hypothalamus is the thalamus. Hypothalamic regulation of hormone secretion The hypothalamus, like the rest of the brain, consists of interconnecting neurons that are nourished by a rich supply of blood. To understand hypothalamic function, it is necessary to define the various forms of neurosecretion. First, there is neurotransmission, which occurs throughout the brain and is the process by which one nerve cell communicates with another via a synapse, a small gap between the ends nerve terminals of neurons. Nerve terminals are often called presynaptic or postsynaptic in reference to the direction in which an impulse is traveling, with the presynaptic neuron transmitting an impulse to the postsynaptic neuron. Transmission of an electrical impulse requires the secretion of a chemical substance that diffuses across the synapse from the presynaptic membrane of one neuron to the postsynaptic membrane of another neuron. The chemical substance that is secreted is called a neurotransmitter. The process of synthesis and secretion of neurotransmitters is similar to that of protein hormone synthesis, with the exception that the neurotransmitters are contained within neurosecretory granules that are produced in the cell body and migrate through the axon a projection of the neuron to the nerve terminal, from which they are discharged into the synaptic space. Intracellular structure of a typical endocrine cell. The process of protein hormone synthesis begins when a hormone or an active metabolite stimulates a receptor in the cell membrane. This leads to the activation of specific molecules of DNA in the nucleus and the formation of a prohormone. The prohormone is transported through the endoplasmic reticulum, is packaged into secretory vesicles in the Golgi apparatus, and is ultimately secreted from the cell in its active, hormone form. There are four classic neurotransmitters: A large number of additional neurotransmitters have been discovered, of which an important group is the neuropeptides. The neuropeptides function not only as neurotransmitters but also as neuromodulators. As neuromodulators, they do not act directly as neurotransmitters but rather increase or decrease the action of neurotransmitters. Well-known examples are the opioids e. The brain and indeed the entire central nervous system consist of an interconnected network of neurons. The secretion of specific neurotransmitters and neuropeptides lends an organized, directed function to the overall system. The connection of the hypothalamus to many other regions of the brain, including the cerebral cortex, allows intellectual and functional signals, as well as external signals, including physical and emotional stresses, to be funneled into the hypothalamus to the endocrine system. From the endocrine system these signals are able to exert their effects throughout the body. The hypothalamus produces and secretes not only neurotransmitters and neuropeptides but also several neurohormones that alter anterior pituitary gland function and two hormones, vasopressin antidiuretic hormone and oxytocin, that act on distant target organs. The neurons that produce and secrete neurohormones are true endocrine cells in that they produce hormones that are incorporated into secretory granules that are then carried through the axons and stored in nerve terminals located in the median eminence or posterior pituitary gland. In response to neural stimuli, the contents of the secretory granules are extruded from the nerve terminals into a capillary network. In the case of hormones that affect pituitary function, the contents of the secretory granules are carried through the hypophyseal-portal circulation and are delivered directly into the anterior pituitary gland. Neurohormones are released from neurosecretory nerve cells. These nerve cells are
HYPOTHALAMIC PEPTIDE HORMONES AND PITUITARY REGULATION

considered true endocrine cells because they produce and secrete hormones that enter the circulation to reach their target cells. These hypothalamic neurohormones are known as releasing hormones because their major function is to stimulate the secretion of hormones originating in the anterior pituitary gland. For example, certain releasing hormones secreted from the hypothalamus trigger the release from the anterior pituitary of substances such as adrenocorticotropic hormone and luteinizing hormone. The hypothalamic neurohormones consist of simple peptides ranging in size from only 3 amino acids thyrotropin-releasing hormone to 44 amino acids growth hormone-releasing hormone. One hypothalamic hormone, somatostatin, has an inhibitory action, primarily inhibiting the secretion of growth hormone although it can also inhibit the secretion of other hormones. The neurotransmitter dopamine, produced in the hypothalamus, also has an inhibitory action, inhibiting the secretion of the anterior pituitary hormone prolactin. The cell bodies of the neurons that produce these neurohormones are not evenly distributed throughout the hypothalamus. Instead, they are grouped together in paired clusters of cell bodies known as nuclei. A classic model for neurohormonal activity is the posterior lobe of the pituitary gland neurohypophysis. Its secretory products, vasopressin and oxytocin, are produced and packaged into neurosecretory granules in specific groups of nerve cells in the hypothalamus the supraoptic nuclei and the paraventricular nuclei. The granules are carried through the axons that extend through the infundibular stalk and end in and form the posterior lobe of the pituitary gland. In response to nerve signals, the secretory granules are extruded into a capillary network that feeds directly into the general circulation. The hypothalamus also regulates body heat in response to variations in external temperature, determines wakefulness and sleep, and regulates fluid intake and sensation of thirst. Hypothalamic disease can also cause insomnia and fluctuations in body temperature. In addition, the optic chiasm is particularly susceptible to pressure from expanding tumours or inflammatory masses in the hypothalamus or the pituitary gland. Pressure on the optic chiasm can result in visual defects or even blindness.
The hypothalamus-pituitary complex can be thought of as the "command center" of the endocrine system. This complex secretes several hormones that directly produce responses in target tissues, as well as hormones that regulate the synthesis and secretion of hormones of other glands.

Projecting inferiorly from the hypothalamus is the pituitary gland Figure 1 and the hypothalamus occupies approximately 2 per cent of the brain volume. The hypothalamus is situated in a strategic position at the crossroad of four systems, neurovegetative, neuroendocrine, limbic, and optic 1. The hypothalamus forms the infenorlateral walls of the third ventricle. The hypothalamus, like the thalamus, contains about a dozen brain nuclei of gray matter. Despite its relatively small size roughly that of a thumbnail or an almond, functionally, the hypothalamus is the main visceral control center of the body, regulating many activities of the visceral organs. It is the hypothalamus that first detects crucial changes in the body and responds by stimulating various glands and organs to release hormones. The hypothalamus is composed of a number of cell groups and can be distinguished into three structurally distinct parts, namely, anterior, middle and posterior regions. These regions are alternately known as the supranoptic, tuberal and mammillary, respectively. Some less anatomically distinct areas can also be found in this brain structure. All these parts are collectively responsible for the production of different essential hormones and chemical substances that control and regulate the functioning of various organs in your body. Anterior Component It is also known as supranoptic region. As the very name suggests, the supranoptic division is located above the optic chiasm where the most prominent nuclei include paraventricular and supraoptic. Other less prominent nuclei are: These nuclei are collectively involved in the secretion of hormones, including oxytocin, vasopressin ADH, corticotropin releasing hormone CRH and somatostatin. It is this region where some of the important body functions are accomplished, such as circadian rhythms, thermoregulation, panting, sweating and differential development between sexes. Middle or Tuberal Component Located at the level of tuber cinereum, the tuberal region is further divided into two parts: Ventromedial nucleus, the largest and most prominent of the nuclei present in the region, is responsible for shaping and controlling eating habits. Some other functions, like the regulation of blood pressure, heart rate, satiety and gastrointestinal stimulation also fall under the domain of tuberal region. Posterior Component The posterior component is composed of medial and lateral areas. Medial area contains two types of hypothalamic nuclei: These nuclei control the functions, like memory, blood pressure, shivering, energy balance, feeding, sleep, arousal and learning. Parts of Hypothalamus Hypothalamus function The hypothalamic functions include the following: Control of the autonomic nervous system. At the autonomic level, the hypothalamus stimulates smooth muscle which lines the blood vessels, stomach, and intestines and receives sensory impulses from these areas. Thus it controls the heart rate and blood pressure, the passage of food through the alimentary canal, the secretion from sweat glands and salivary glands and contraction of the bladder and many other visceral activities. The hypothalamus exerts its control over visceral functions by relaying its instructions through the periaqueductal gray matter of the midbrain and the reticular formation of the brain stem, which then carry out those instructions. Regulation of body temperature. In the hypothalamus are neurons that monitor body temperature at the surface through nerve endings in the skin and other neurons that monitor the blood flowing through this part of the brain itself, as an indicator of core body temperature. The front part of the hypothalamus contains neurons that act to lower body temperature by relaxing smooth muscle in the blood vessels, which causes them to dilate and increases the rate of heat loss from the skin. Through its neurons associated with the sweat glands of the skin, the hypothalamus can also promote heat loss by increasing the rate of perspiration. Hypothalamic centers also induce fever. Regulation of hunger and thirst sensations. The hypothalamus is the control center for the stimuli that underlie eating and drinking. By sensing the concentrations of nutrients and salts in the blood, certain hypothalamic neurons mediate feelings of hunger and thirst and thus aid in maintaining the proper concentrations of these substances. The sensations that you
interpret as hunger arise partly from a degree of emptiness in the stomach and partly from a drop in the level
of two substances: Receptors for this hormone gauge how far digestion has proceeded since the last meal. In
experimental animals, damage to this portion of the brain is associated with continued excessive eating,
eventually leading to obesity. Regulation of sleep-wake cycles. Acting with other brain regions, the
hypothalamus helps regulate the complex phenomenon of sleep. It generates the daily circadian rhythms and
synchronizes these cycles in response to dark-light information sensed via the optic nerve. In response to such
signals, the preoptic nucleus induces sleep. Electrical stimulation of a portion of the hypothalamus has been
shown to induce sleep in experimental animals, although the mechanism by which this works is not yet
known. Other hypothalamic nuclei near the mammillary body mediate arousal from sleep. Furthermore, the
hypothalamus forms part of the reticular activating system, the physical basis for that hard-to-define state
known as consciousness. Control of the endocrine system. The hypothalamus controls the secretion of
hormones by the pituitary gland, which in turn influences the activity of many other endocrine organs. Control
of emotional responses. The hypothalamus lies at the center of the emotional part of the brain, the limbic
system. Regions involved in pleasure, rage, and fear are located in the hypothalamus. When strong feelings
rage, fear, pleasure, excitement are generated in the mind, whether by external stimuli or by the action of
thoughts, the cerebral cortex transmits impulses to the hypothalamus; the hypothalamus may then send signals
for physiological changes through the autonomic nervous system and through the release of hormones from
the pituitary. Control of motivational behavior. The hypothalamus controls behavior that is rewarding. For
example, the hypothalamus influences your motivation for feeding, thereby determining how much you eat,
and also influences sex drive and sexual behavior. The brain nucleus in the mammillary body receives many
inputs from the major memory processing structure of the cerebrum, the hippocampal formation. Lesions of
the hypothalamus cause disorders in visceral functions and in emotions. Thus, injuries to the hypothalamus
can result in severe weight loss or obesity, sleep disturbances, dehydration, and a broad range of emotional
disorders. In all, the hypothalamus is a richly complex cubic centimeter of vital connections, which will
continue to reward close study for some time to come. Because of its unique position as a midpost between
thought and feeling and between conscious act and autonomic function, a thorough understanding of its
workings should tell us much about the earliest history and development of the human animal. Summary of
the hypothalamus functions: Heart rate and arterial blood pressure Body temperature Control of hunger and
body weight Control of movements and glandular secretions of the stomach and intestines Production of
hormones that stimulate the pituitary gland to secrete pituitary hormones Sleep and wakefulness Memory.
Schematic representation of the major neural pathways connecting the periventricular, medial and lateral
hypothalamic subdivisions with the rest of the brain Appetite control and hypothalamus The hypothalamus is a
major integrator of hormonal and nutrient-induced signals of hunger and satiety with the aim of regulating
energy stores and food intakes. The central role of the hypothalamus in the control of feeding has emerged in
the past century from lesioning studies. Indeed, various lesions of the ventromedial hypothalamus were shown
to cause hyperphagia and obesity 2 while lesions of the lateral hypothalamus caused reduced food intake and
leanness 3. These studies indicated that key hypothalamic areas activate responses to promote negative energy
balance i. Accordingly, impaired responses or a sort of resistance to afferent input from these hormonal or
nutrient-related signals would be predicted to favor weight gain and insulin resistance and may contribute to
the development of obesity and type 2 diabetes 4. Many reports have been focused on the identification of
hypothalamic pathways that control energy but recent evidence suggests, however, that in addition to playing
a critical role in the regulation of energy homeostasis, the central nervous system also control peripheral
metabolisms such as glucose metabolism via hypothalamic sensors detecting nutrients availability.
Mechanisms of appetite control became a public health focus because of its numerous clinical implications of
obesity, currently reaching world epidemic levels. Weight loss is one of the main therapeutic goals to decrease
the related morbidity and mortality of obesity. The neurobehavioral aspects of obesity are complex and poorly
understood, food sensing and craving are currently major areas of research. The neurologic component of food
regulation is centered on the hypothalamus. Recently, functional changes in brain activities in response to food have been seen in humans by using functional magnetic resonance imaging fMRI. These data emphasize the major regulatory action of central metabolic sensing in the regulation of body weight, however, the modifications of brain structure and function during morbid obesity are still poorly realized. Recently, Thaler et al. Five hypothalamic nuclei are known to be involved in appetite control. The lateral nucleus, the ventromedial and dorsomedial nuclei, the paraventricular nucleus and the arcuate or infundibular nucleus. Although clinical benefit of chronic electric stimulation of lateral hypothalamus is still unproved in humans, recent animals studies have demonstrated weight control using electric modulation of the ventromedial nucleus.

Visual system and hypothalamus The retino-hypothalamus tract is the main connection between the eye and the hypothalamus, a direct afferent pathway from the retina, going through the optic chiasma. In mammalians, axons of photosensitive retinal ganglion cells, expressing melanopsin, project to the suprachiasmatic nucleus. The supra chiasmatic nucleus, the supra optic nucleus, and the sub periventricular area; the olivary pretectal nucleus, the intergeniculate leaflets of the geniculate nuclei, the medial amygdala, the lateral habenula, the nucleus posterior limitans of the thalamus, the superior colliculus and the periaqueductal gray. Sadun and Schaechter described first in human the retino-hypothalamus tract, which penetrates the hypothalamus into the suprachiasmatic nucleus, ending locally and in the paraventricular nucleus. The supra chiasmatic nucleus is well-known as the hypothalamic clock, synchronizing several biorhythms such as sleep-arousal and food intake; in rats the ventromedial and the lateral nuclei also have circadian rhythms. Limbic system and hypothalamus Two groups of hypothalamic nuclei are directly involved in the limbic circuitry, the preoptic and the mammillary. Broadly the preoptic connects the frontal lobe, the thalamo-tegmental region, the septum, the lenticular nucleus, the substantia innominata of Reichert, and the anterior perforate; mainly through the basal forebrain bundle, the ansa lenticularis, and the radiate system; the medial nucleus of the preoptic nucleus being in continuity with the nucleus of the stria terminalis. The mammillary nuclei participate to the limbic circuitry through the fornix and the mammillo-thalamic bundle. The fornix emerges from the hippocampus and terminates anteriorly and laterally, into the ipsilateral mammillary body; the precommissural fornix could be continuous with the diagonal band of Broca. The mammillo-thalamic bundle terminates into the ipsilateral anterior nucleus of the thalamus, from which neuronal relays go to the cingulum. From a white matter tract point of view, the stria medullaris of the thalamus connects the epithalamus or habenula, with the preoptic and septal regions, and also possibly with the nucleus of Meynert. The basal forebrain bundle, bidirectional, links the upper brain stem, mostly the tegmentum with the anterolateral hypothalamus, the olfactory region, the septum, the nucleus accumbens, the amygdala, and the substantia innominata of Reichert. The diagonal band of Broca connects the septal region, the anterior perforate region and the olfactory area with the amygdala, and possibly the lateral hypothalamus. In rats, hypothalamic stimulation enhances hippocampal plasticity. In humans, deep brain stimulation of the lateral hypothalamus close to the fornix seems to improve memory processing. Hypothalamus hormones Control of the endocrine system occurs in three ways: Hypothalamus Hormones Thus far, 7 physiologically important hypothalamic neurohormones have been identified see Table 1: Except for the biogenic amine dopamine, all are small peptides. Several are produced in the periphery as well as in the hypothalamus and function in local paracrine systems, especially in the gastrointestinal tract. Vasoactive intestinal peptide, which also stimulates the release of prolactin, is one. Neurohormones may control the release of multiple pituitary hormones. Regulation of most anterior pituitary hormones depends on stimulatory signals from the hypothalamus; the exception is prolactin, which is regulated by inhibitory stimuli. If the pituitary stalk which connects the pituitary to the hypothalamus is severed, prolactin release increases, whereas release of all other anterior pituitary hormones decreases.
Glucagon-like peptide 1 The extreme lateral part of the ventromedial nucleus of the hypothalamus is responsible for the control of food intake. Stimulation of this area causes increased food intake. Bilateral lesion of this area causes complete cessation of food intake. Medial parts of the nucleus have a controlling effect on the lateral part. Bilateral lesion of the medial part of the ventromedial nucleus causes hyperphagia and obesity of the animal. Further lesion of the lateral part of the ventromedial nucleus in the same animal produces complete cessation of food intake. There are different hypotheses related to this regulation: This hypothesis holds that adipose tissue produces a humoral signal that is proportionate to the amount of fat and acts on the hypothalamus to decrease food intake and increase energy output. It has been evident that a hormone leptin acts on the hypothalamus to decrease food intake and increase energy output. The food entering the gastrointestinal tract triggers the release of these hormones, which act on the brain to produce satiety. The activity of the satiety center in the ventromedial nuclei is probably governed by the glucose utilization in the neurons. It has been postulated that when their glucose utilization is low and consequently when the arteriovenous blood glucose difference across them is low, the activity across the neurons decrease. Under these conditions, the activity of the feeding center is unchecked and the individual feels hungry. Food intake is rapidly increased by intraventricular administration of 2-deoxyglucose therefore decreasing glucose utilization in cells. According to this hypothesis, a decrease in body temperature below a given set-point stimulates appetite, whereas an increase above the set-point inhibits appetite. Fear processing[edit] The medial zone of hypothalamus is part of a circuitry that controls motivated behaviors, like defensive behaviors. Fos-labeled cell analysis showed that the PMDvl is the most activated structure in the hypothalamus, and inactivation with muscimol prior to exposure to the context abolishes the defensive behavior. Social defeat Likewise, the hypothalamus has a role in social defeat: Nuclei in medial zone are also mobilized during an encounter with an aggressive conspecific. The defeated animal has an increase in Fos levels in sexually dimorphic structures, such as the medial pre-optic nucleus, the ventrolateral part of ventromedial nucleus, and the ventral premammillary nucleus. Moreover, the premammillary nucleus also is mobilized, the dorsomedial part but not the ventrolateral part. Swaab, writing in a July paper, "Neurobiological research related to sexual orientation in humans is only just gathering momentum, but the evidence already shows that humans have a vast array of brain differences, not only in relation to gender, but also in relation to sexual orientation. In , Swaab and Hofman [38] reported that the suprachiasmatic nucleus in homosexual men was significantly larger than in heterosexual men. Then in , Swaab et al. This produced an enlarged SCN and bisexual behavior in the adult male rats. In , LeVay showed that part of the sexually dimorphic nucleus SDN known as the 3rd interstitial nucleus of the anterior hypothalamus INAH 3 , is nearly twice as large in terms of volume in heterosexual men than in homosexual men and heterosexual women. However, a study in has shown that the sexually dimorph nucleus of the preoptic area, which include the INAH3, are of similar size in homosexual males who died of AIDS to heterosexual males, and therefore larger than female. This clearly contradicts the hypothesis that homosexual males have a female hypothalamus. Furthermore, the SCN of homosexual males is extremely large both the volume and the number of neurons are twice as many as in heterosexual males. These areas of the hypothalamus have not yet been explored in homosexual females nor bisexual males nor females. These studies showed that the hypothalamus of heterosexual men and homosexual women both respond to estrogen. Also, the hypothalamus of homosexual men and heterosexual women both respond to testosterone. The hypothalamus of all four groups did not respond to the common odors, which produced a normal olfactory response in the brain. Human brain left dissected midsagittal view Location of the hypothalamus.
Chapter 4: Hypothalamus | Definition, Anatomy, & Function | blog.quintoapp.com

The proceedings of a workshop conference are presented in this volume entitled Hypothalamic Peptide Hormones and Pituitary Regulation. The workshop was held in Wilson Hall on the campus of the National Institutes of Health, Bethesda, Maryland, during the days of November , , and is the most recent of three symposia on neuroendocrinology.

Chapter 5: Hypothalamus - Functions, Hypothalamus Hormones and Disorders

The hypothalamus is a portion of the brain that contains a number of small nuclei with a variety of functions. One of the most important functions of the hypothalamus is to link the nervous system to the endocrine system via the pituitary gland.

Chapter 6: Hypothalamus - Wikipedia

CRH is the key hypothalamic peptide controlling the hypothalamic-pituitary-adrenal (HPA) axis. It plays a central role in the response of the organism to stress, defined broadly as any change in the environment threatening the homeostasis of the individual.