BIOLOGICAL CONTROL SYSTEMS

CARDIOVASCULAR CONTROL SYSTEM:

The cardiovascular centre is a part of the human brain responsible for the regulation of the rate at which the heart beats through the nervous and endocrine systems. It is found in the medulla oblongata. Normally, the heart beats without nervous control, but in some situations (e.g., exercise, body trauma), the cardiovascular centre is responsible for altering the rate at which the heart beats. It also mediates respiratory sinus arrhythmia.

When a change of blood pH is detected by chemoreceptors or a change of blood pressure is detected by stretch receptors in aortic and carotid bodies, the cardiovascular centre effects changes to the heart rate by sending nerve impulse to pacemaker (or SA node) via sympathetic fibres (to cause faster and stronger cardiac muscle contraction) and the vagus nerve (to cause slower and less strong cardiac muscle contraction). The cardiovascular centre also increases the stroke volume of the heart (that is, the amount of blood it pumps). These two changes help to regulate the cardiac output, so that a sufficient amount of blood reaches tissue.

Hormones like epinephrine and norepinephrine can affect the cardiovascular centre and cause it to increase the rate of impulses sent to the sinoatrial node, or "cardiac pacemaker", resulting in faster and stronger cardiac muscles contraction and thus increasing the rate of the heart beat.Chemoreceptors may also prompt this regulation.

The circulatory system, also called the cardiovascular system or the vascular system, is an organ system that permits blood to circulate and transport nutrients (such as amino acids and electrolytes), oxygen, carbon dioxide, hormones, and blood cells to and from the cells in the body to provide nourishment and help in fighting diseases, stabilize temperature and pH, and maintain homeostasis. The study of the blood flow is called hemodynamics. The study of the properties of the blood flow is called hemorheology.

The circulatory system is often seen to comprise two separate systems: the cardiovascular system, which distributes blood, and the lymphatic system, which circulates lymphThe passage of lymph for example takes much longer than that of bloodBlood is a fluid consisting of plasma, red blood cells, white blood cells, and platelets that is circulated by the heart through the vertebrate vascular system, carrying oxygen and nutrients to and waste materials away from all body tissues. Lymph is essentially recycled excess blood plasma after it has been filtered from

the interstitial fluid (between cells) and returned to the lymphatic system. The cardiovascular (from Latin words meaning "heart" and "vessel") system comprises the blood, heart, and blood vessels The lymph, lymph nodes, and lymph vessels form the lymphatic system, which returns filtered blood plasma from the interstitial fluid (between cells) as lymph.

While humans, as well as other vertebrates, have a closed cardiovascular system (meaning that the blood never leaves the network of arteries, veins and capillaries), some invertebrate groups have an open cardiovascular system. The lymphatic system, on the other hand, is an open system providing an accessory route for excess interstitial fluid to be returned to the bloodThe more primitive, diploblastic animal phyla lack circulatory systems.

The essential components of the human cardiovascular system are the heart, blood and blood vesselsIt includes the pulmonary circulation, a "loop" through the lungs where blood is oxygenated; and the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood. The systemic circulation can also be seen to function in two parts–a macrocirculation and a microcirculation. An average adult contains five to six quarts (roughly 4.7 to 5.7 liters) of blood, accounting for approximately 7% of their total body weightBlood consists of plasma, red blood cells, white blood cells, and platelets. Also, the digestive system works with the circulatory system to provide the nutrients the system needs to keep the heart pumping

The cardiovascular systems of humans are closed, meaning that the blood never leaves the network of blood vessels. In contrast, oxygen and nutrients diffuse across the blood vessel layers and enter interstitial fluid, which carries oxygen and nutrients to the target cells, and carbon dioxide and wastes in the opposite direction. The other component of the circulatory system, the lymphatic system, is open

Arteries

Oxygenated blood enters the systemic circulation when leaving the left ventricle, through the aortic semilunar valve. The first part of the systemic circulation is the aorta, a massive and thick-walled artery. The aorta arches and branches into major arteries to the upper body before

passing through the diaphragm, where it branches further into arteries which supply the lower parts of the body.

Capillaries

Arteries branch into small passages called arterioles and then into the capillaries.[8] The capillaries merge to bring blood into the venous system.[9]

Veins

After their passage through body tissues, capillaries merge once again into venules, which continue to merge into veins. The venous system finally coalesces into two major veins: the superior vena cava (roughly speaking draining the areas above the heart) and the inferior vena cava (roughly speaking from areas below the heart). These two great vessels empty into the right atrium of the heart.

Coronary vessels

The heart itself is supplied with oxygen and nutrients through a small "loop" of the systemic circulation.

Portal veins

The general rule is that arteries from the heart branch out into capillaries, which collect into veins leading back to the heart. Portal veins are a slight exception to this. In humans the only significant example is the hepatic portal vein which combines from capillaries around the gut where the blood absorbs the various products of digestion; rather than leading directly back to the heart, the hepatic portal vein branches into a second capillary system in the liver.

ENDOCRINECONTROLSYSTEM

The endocrine system refers to the collection of glands of an organism that secrete hormones directly into the circulatory system to be carried towards distant target organs. The major endocrine glands include the pineal gland, pituitary gland, pancreas, ovaries, testes, thyroid gland, parathyroid gland, hypothalamus, gastrointestinal tract and adrenal glands. The endocrine system is in contrast to the exocrine system, which secretes its hormones to the outside of the body using ducts. The endocrine system is an information signal system like the nervous system, yet its effects and mechanism are classifiably different. The endocrine system's effects are slow

to initiate, and prolonged in their response, lasting from a few hours up to weeks. The nervous system sends information very quickly, and responses are generally short lived. In vertebrates, the hypothalamus is the neural control center for all endocrine systems. The field of study dealing with the endocrine system and its disorders is endocrinology, a branch of internal medicineSpecial features of endocrine glands are, in general, their ductless nature, their vascularity, and commonly the presence of intracellular vacuoles or granules that store their hormones. In contrast, exocrine glands, such as salivary glands, sweat glands, and glands within the gastrointestinal tract, tend to be much less vascular and have ducts or a hollow lumen.

In addition to the specialized endocrine organs mentioned above, many other organs that are part of other body systems, such as bone, kidney, liver, heart and gonads, have secondary endocrine functions. For example, the kidney secretes endocrine hormones such as erythropoietin and renin. Hormones can consist of either amino acid complexes, steroids, eicosanoids, leukotrienes, or prostaglandins.

A number of glands that signal each other in sequence are usually referred to as an axis, for example, the hypothalamic-pituitary-adrenal axis.

Interaction of hormones at target cells

Permissiveness is the situation in which a hormone cannot exert its full effects without the presence of another hormone.

Synergyism occurs when two or more hormones produce the same effects in a target cell and their results are amplified.

Antagonism occurs when a hormone opposes or reverses the effect of another hormone.

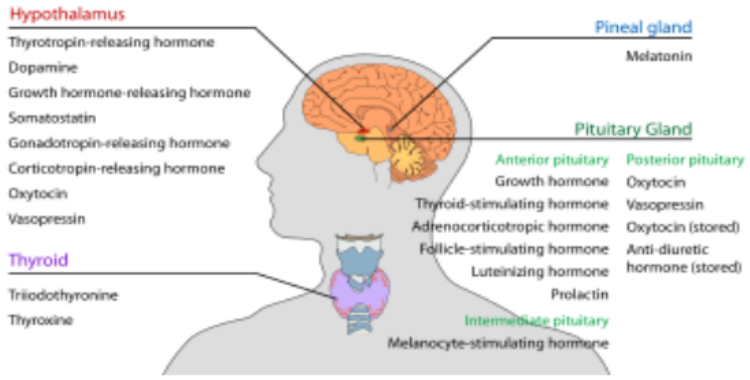
Control of hormone release

Endocrine organs are activated to release their hormones by humoral, neural or hormonal stimuli. Negative feedback is important in regulating hormone levels in the blood.

The nervous system, acting through hypothalamic controls, can in certain cases override or modulate hormonal effects.

Major endocrine organs

Pituitary gland (hypophysis)[edit]



Endocrine glands in the human head and neck and their hormones

Main article: Pituitary gland

The pituitary gland hangs from the base of the brain by a stalk and is enclosed by bone. It consists of a hormone-producing glandular portion (anterior pituitary) and a neural portion (posterior pituitary), which is an extension of thehypothalamus. The hypothalamus regulates the hormonal output of the anterior pituitary and synthesizes two hormones that it exports to the posterior pituitary for storage and later release.

Four of the six adenohypophyseal hormones are tropic hormones that regulate the function of other endocrine organs. Most anterior pituitary hormones exhibit a diurnal rhythm of release, which is subject to modification by stimuli influencing the hypothalamus.

Somatotropic hormone or Growth hormone (GH) is an anabolic hormone that stimulates growth of all body tissues but especially skeletal muscle and bone. It may act directly, or indirectly via insulin-like growth factors (IGFs). GH mobilizes fats, stimulates protein synthesis, and inhibits glucose uptake and metabolism. Secretion is regulated bygrowth hormone releasing hormone (GHRH) and growth hormone inhibiting hormone (GHIH), or somatostatin. Hypersecretion causes gigantism in children and acromegaly in adults; hyposecretion in children causes pituitary dwarfism.

Thyroid-stimulating hormone (TSH) promotes normal development and activity of the thyroid gland. Thyrotropin-releasing hormone (TRH) stimulates its release; negative feedback of thyroid hormone inhibits it.

Adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex to release corticosteroids. ACTH release is triggered by corticotropin-releasing hormone (CRH) and inhibited by rising glucocorticoid levels.

The gonadotropins—follicle-stimulating hormone (FSH) and luteinizing hormone (LH) regulate the functions of the gonads in both sexes. FSH stimulates sex cell production; LH stimulates gonadal hormone production. Gonadotropin levels rise in response to gonadotropin-releasing hormone (GnRH). Negative feedback of gonadal hormones inhibits gonadotropin release.

Prolactin (PRL) promotes milk production in humans females. Its secretion is prompted by prolactin-releasing hormone (PRH) and inhibited by prolactin-inhibiting hormone (PIH).

The neurohypophysis stores and releases two hypothalamic hormones:

- Oxytocin stimulates powerful uterine contractions, which trigger labor and delivery of an infant, and milk ejection in nursing women. Its release is mediated reflexively by the hypothalamus and represents a positive feedback mechanism.
- Antidiuretic hormone (ADH) stimulates the kidney tubules to reabsorb and conserve water, resulting in small volumes of highly concentrated urine and decreased plasma osmolarity. ADH is released in response to high solute concentrations in the blood and inhibited by low solute concentrations in the blood. Hyposecretion results in diabetes insipidus.

Thyroid gland

The thyroid gland is located in the anterior throat. Thyroid follicles store colloid containing thyroglobulin, a glycoprotein from which thyroid hormone is derived.

Thyroid hormone (TH) includes thyroxine (T4) and triiodothyronine (T3), which increase the rate of cellular metabolism. Consequently, oxygen use and heat production rise.

Secretion of thyroid hormone, prompted by TSH, requires reuptake of the stored colloid by the follicle cells and splitting of the hormones from the colloid for release. Rising levels of thyroid hormone feed back to inhibit the pituitary and hypothalamus.

Most T4 is converted to T3 (the more active form) in the target tissues. These hormones act by turning on gene and protein synthesis.

Graves' disease is the most common cause of hyperthyroidism; hyposecretion causes cretinism in infants and myxoedema in adults.

Calcitonin, produced by the parafollicular cells of the thyroid gland in response to rising blood calcium levels, depresses blood calcium levels by inhibiting bone matrix resorption and enhancing calcium deposit in bone.

Parathyroid glands

The parathyroid glands, located on the dorsal aspect of the thyroid gland, secrete parathyroid hormone (PTH),[1] which causes an increase in blood calcium levels by targeting bone, the intestine, and the kidneys. PTH is the antagonist of calcitonin. PTH release is triggered by falling blood calcium levels and is inhibited by rising blood calcium levels.

Hyperparathyroidism results in hypercalcaemia and all its effects and in extreme bone wasting. Hypoparathyroidism leads to hypocalcaemia, evidenced by tetany and respiratory paralysis.

Pancreas

The pancreas, located in the abdomen close to the stomach, is both an exocrine and an endocrine gland. The alpha and beta cells are the endocrine cells in the pancreatic isletsthat release insulin and glucagon and smaller amounts of other hormones into the blood.

Glucagon is released by alpha (α) cells when the blood glucose level is low, and this stimulates the liver to release glucose into the blood.

Insulin is released by beta (β) cells when blood levels of glucose (and amino acids) are rising. It increases the rate of glucose uptake and metabolism by most body cells. Hyposecretion of insulin results in diabetes mellitus; cardin**al signs are polyuria, polydipsia, and polyphagia.**

Gonads

The ovaries of the female, located in the pelvic cavity, release two main hormones. Secretion of estrogens by the ovarian follicles begins at puberty under the influence of FSH. Estrogens

stimulate maturation of the female reproductive system and development of the secondary sexual characteristics. Progesterone is released in response to high blood levels of LH. It works with estrogens in establishing the menstrual cycle.

The testes of the male begin to produce testosterone at puberty in response to LH. Testosterone promotes maturation of the male reproductive organs, development of secondary sex characteristics, and production of sperm by the testes.

Pineal gland

The pineal gland is located in the diencephalon. Its primary hormone is melatonin, which influences daily rhythms and may have an antigonadotropic effect in humans.

Other hormone-producing structures

Many body organs not normally considered endocrine organs contain isolated cell clusters that secrete hormones. Examples include the heart (atrial natriuretic peptide);gastrointestinal tract organs (gastrin, secretin, and others); the placenta (hormones of pregnancy—estrogen, progesterone, and others); the kidneys (erythropoietin and renin); the thymus; skin (cholecalciferol); and adipose tissue (leptin and resistin).

Developmental aspects of the endocrine systems

Endocrine glands derive from all three germ layers. Those derived from mesoderm produce steroidal hormones; the others produce the amino acid–based hormones.

The natural decrease in function of the female's ovaries during late middle age results in menopause. The efficiency of all endocrine glands seems to decrease gradually as aging occurs. This leads to a generalized increase in the incidence of diabetes mellitus and a lower metabolic rate.