THE AUTONOMIC NERVOUS SYSTEM

Prof. M. Gavriliuc

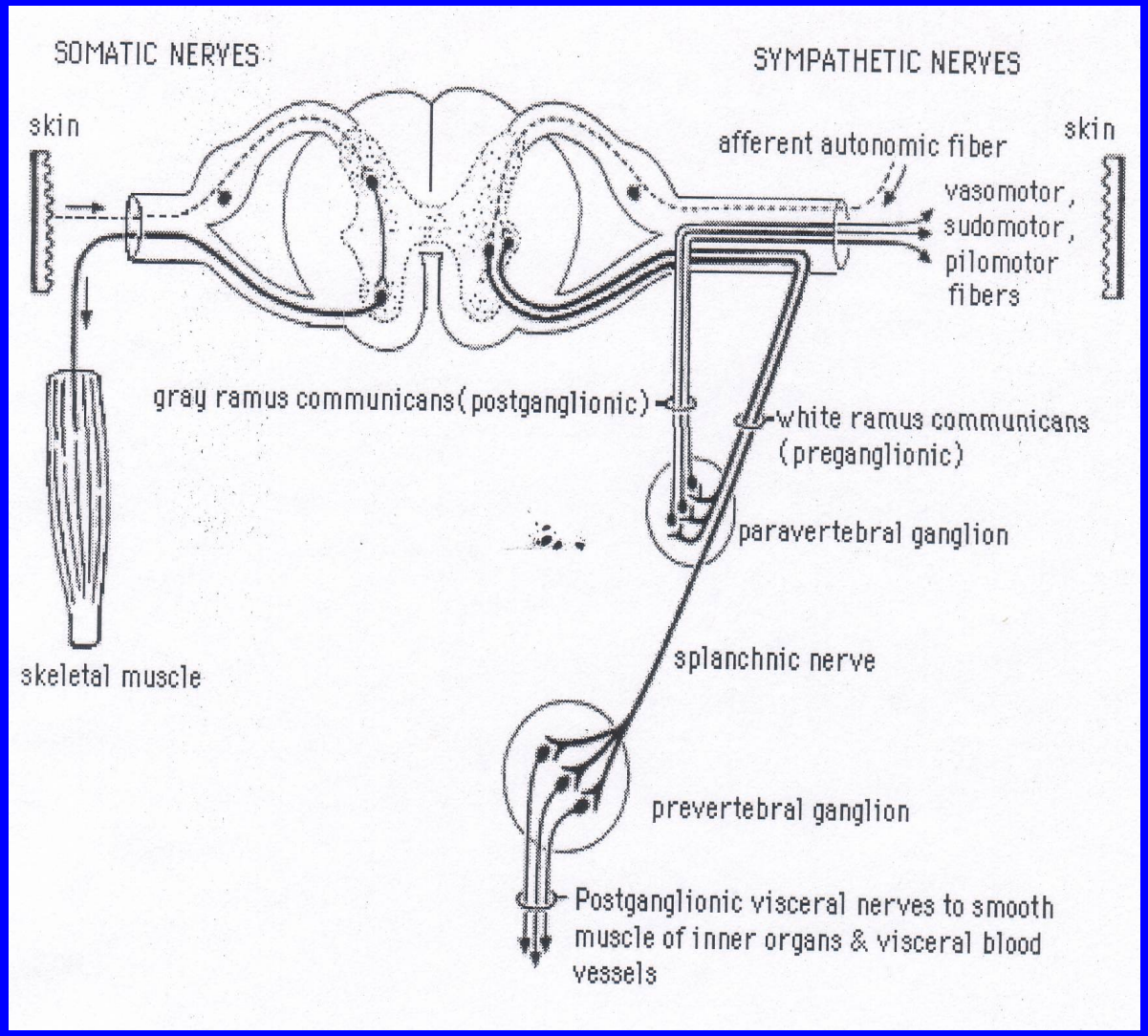
THE AUTONOMIC NERVOUS SYSTEM ANATOMIC AND PHYSIOLOGIC CONSIDERATION

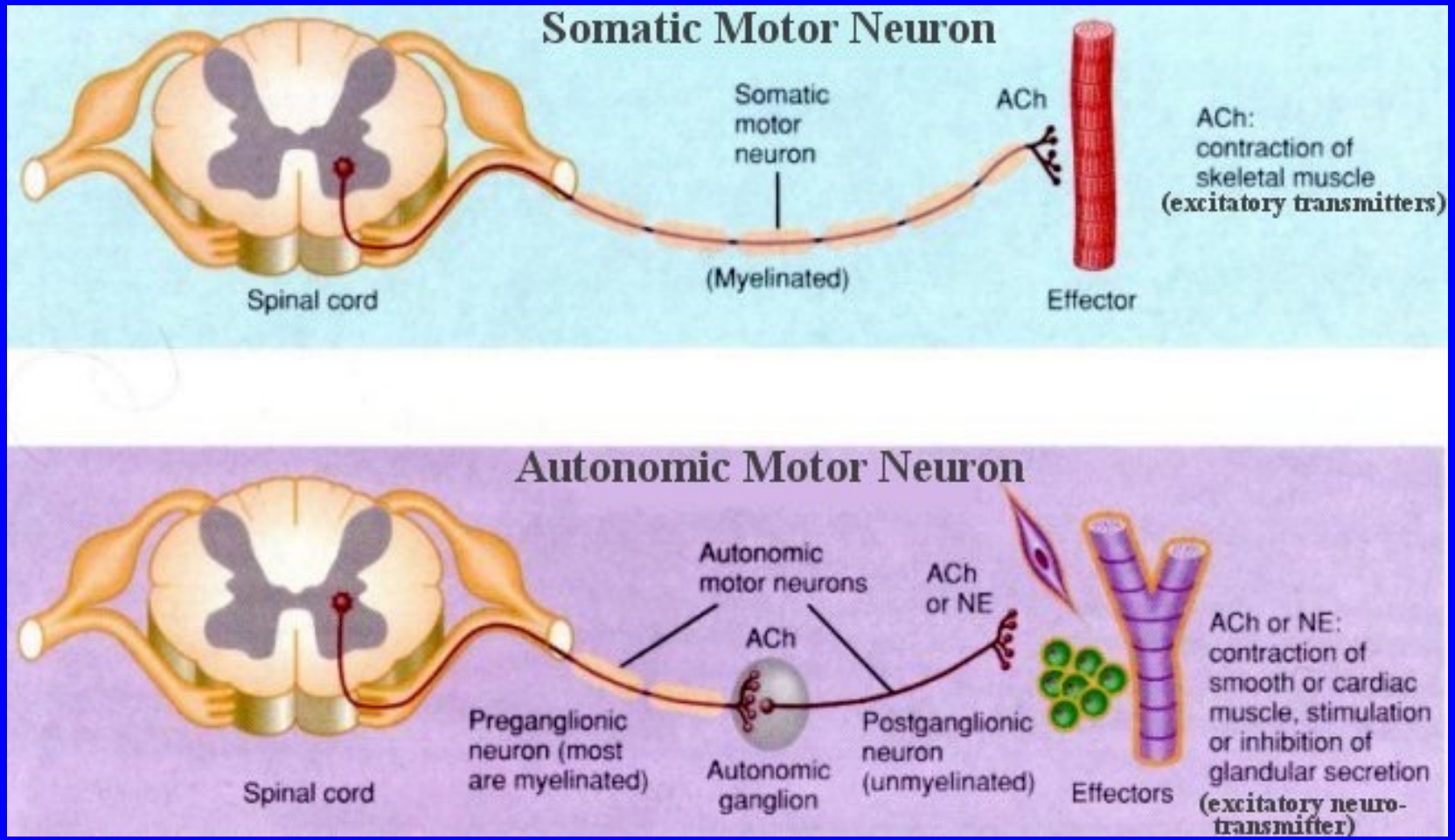
The human internal environment is regulated in large measure by the integrated activity of the autonomic nervous system and endocrine glands. Their visceral and homeostatic functions, essential to life and the survival of our species, are involuntary.

The most remarkable feature of the autonomic nervous system (also called the visceral, vegetative, or involuntary nervous system) is that a major part of it is located outside the cerebrospinal system, in proximity to the visceral structures that it innervates.

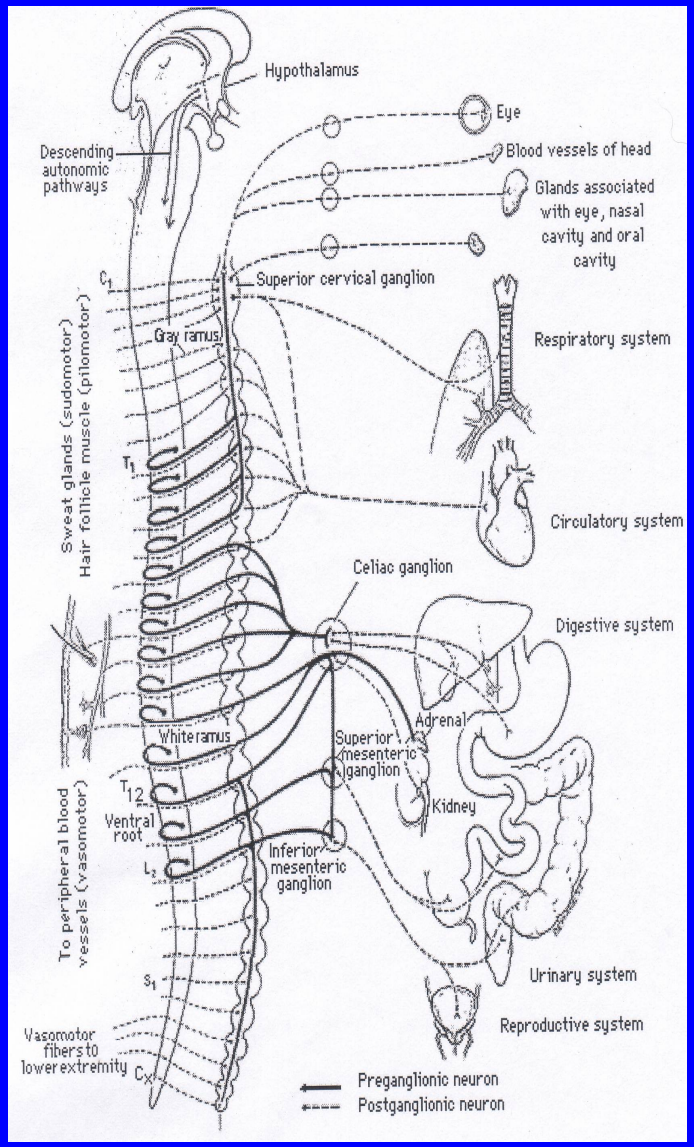
THE AUTONOMIC NERVOUS SYSTEM ANATOMIC AND PHYSIOLOGIC CONSIDERATION

In distinction to the somatic neuromuscular system, where a single motor neuron bridges the gap between the central nervous system and the effector organ, in the autonomic nervous system there are always two motor neurons serving this function - one (preganglionic) arising from its nucleus in the brainstem or spinal cord and the other (postganglionic) arising from specialized peripheral ganglia.

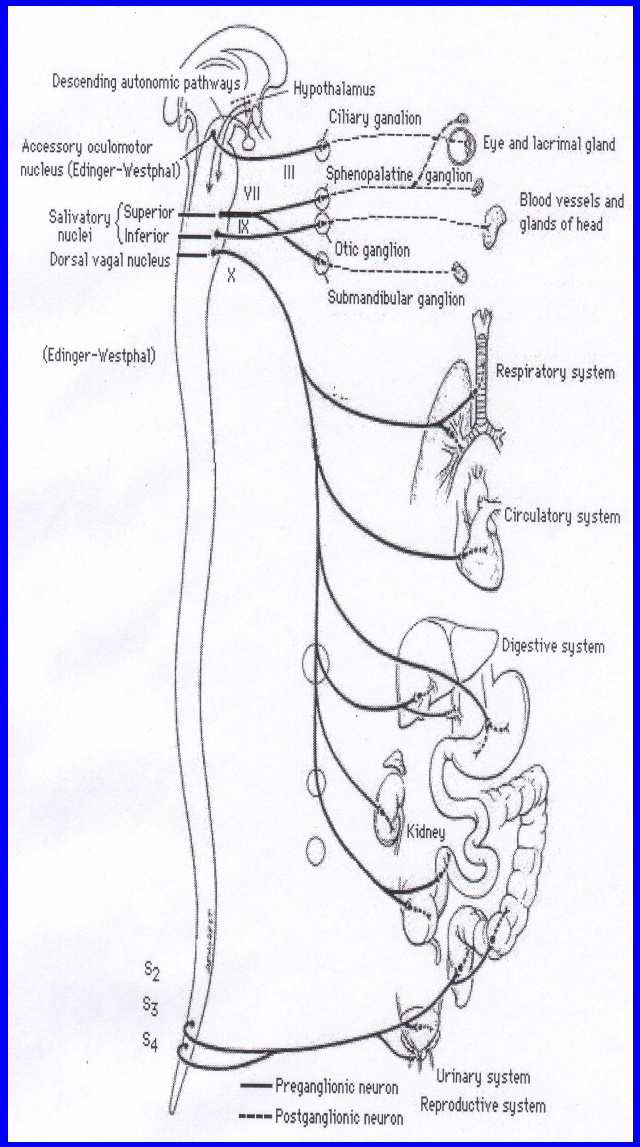



Somatic Motor Neuron
Somatic motor neuron
ACh
ACh: contraction of skeletal muscle (excitatory transmitters)
Spinal cord
(Myelinated)
Effector
Autonomic Motor Neuron
Autonomic motor neurons
ACh or NE
ACh
ACh or NE: contraction of smooth or cardiac muscle, stimulation or inhibition of glandular secretion (excitatory neuro-transmifter)
Preganglionic neuron (most are myelinated)
Postganglionic neuron (unmyelinated)
Spinal cord
Autonomic ganglion
Effectors

THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION

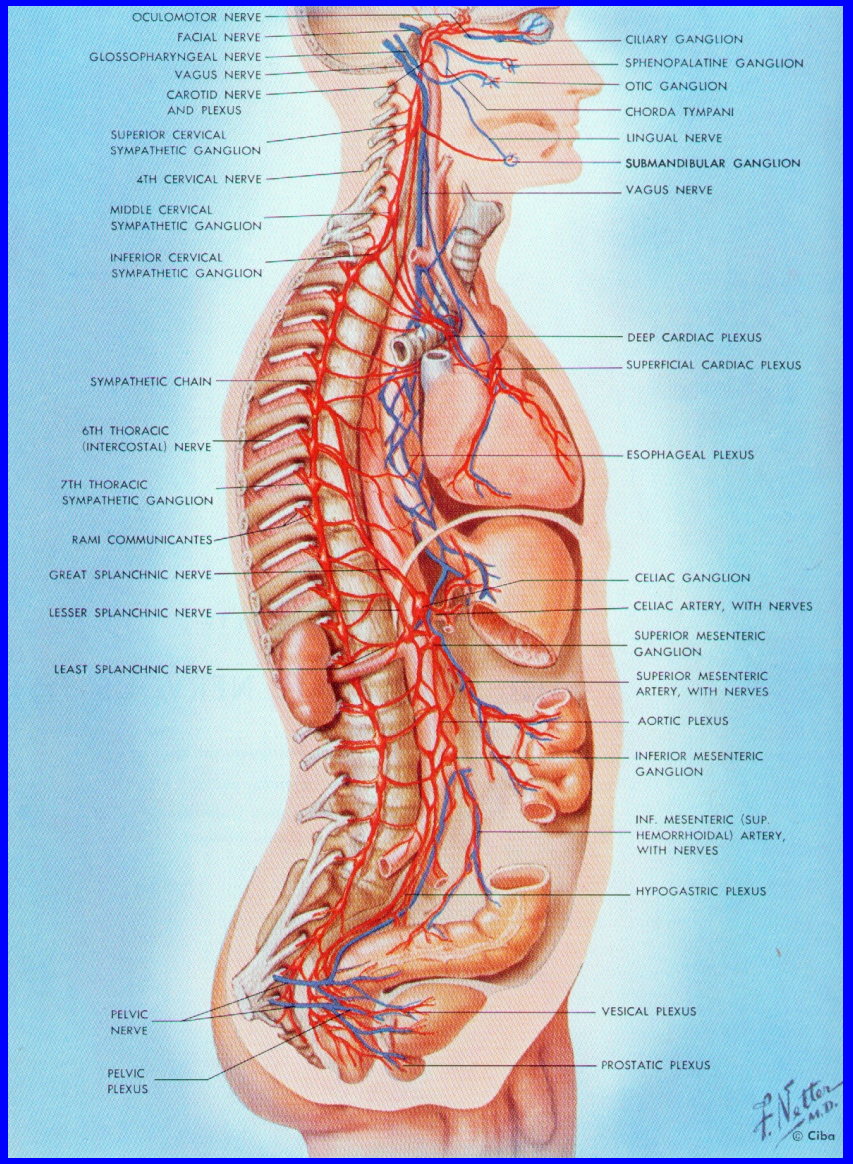


From a strictly anatomic point of view, the autonomic nervous system is divided into two parts: thoracolumbar, or sympathetic, and craniosacral, or parasympathetic



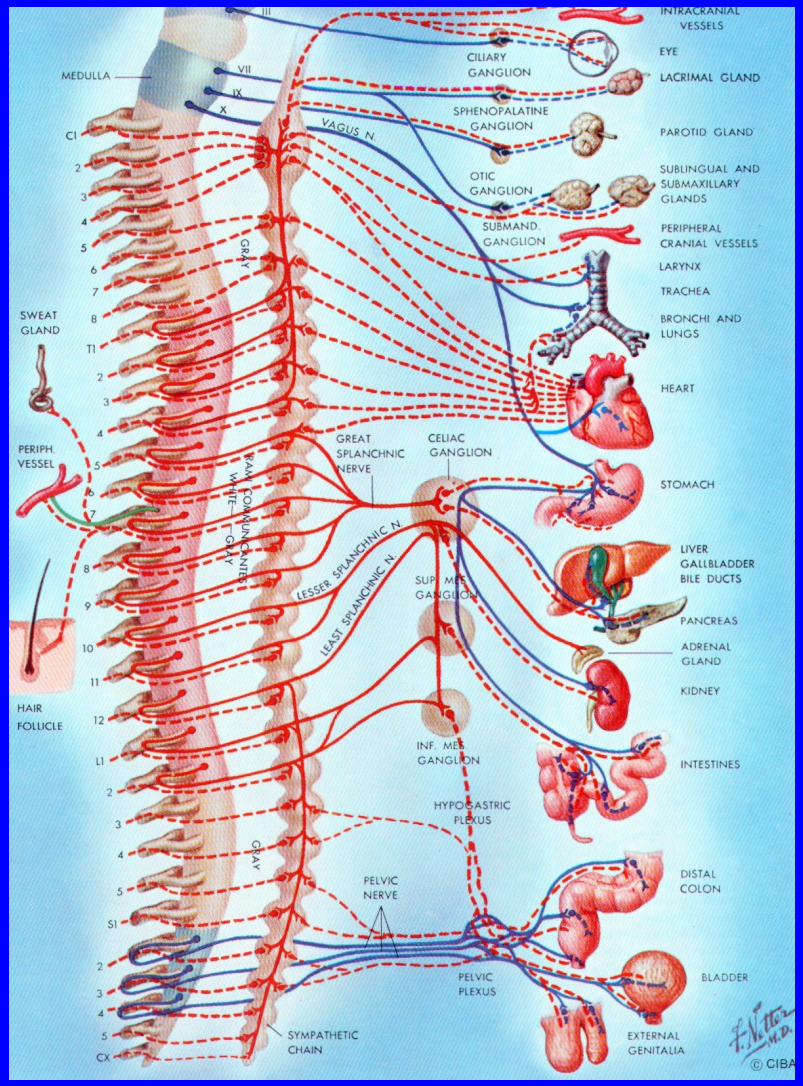
THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION

Functionally, the two parts are complementary in maintaining a balance in the tonic activities of many visceral structures and organs.



THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION
The Parasympathetic Nervous System

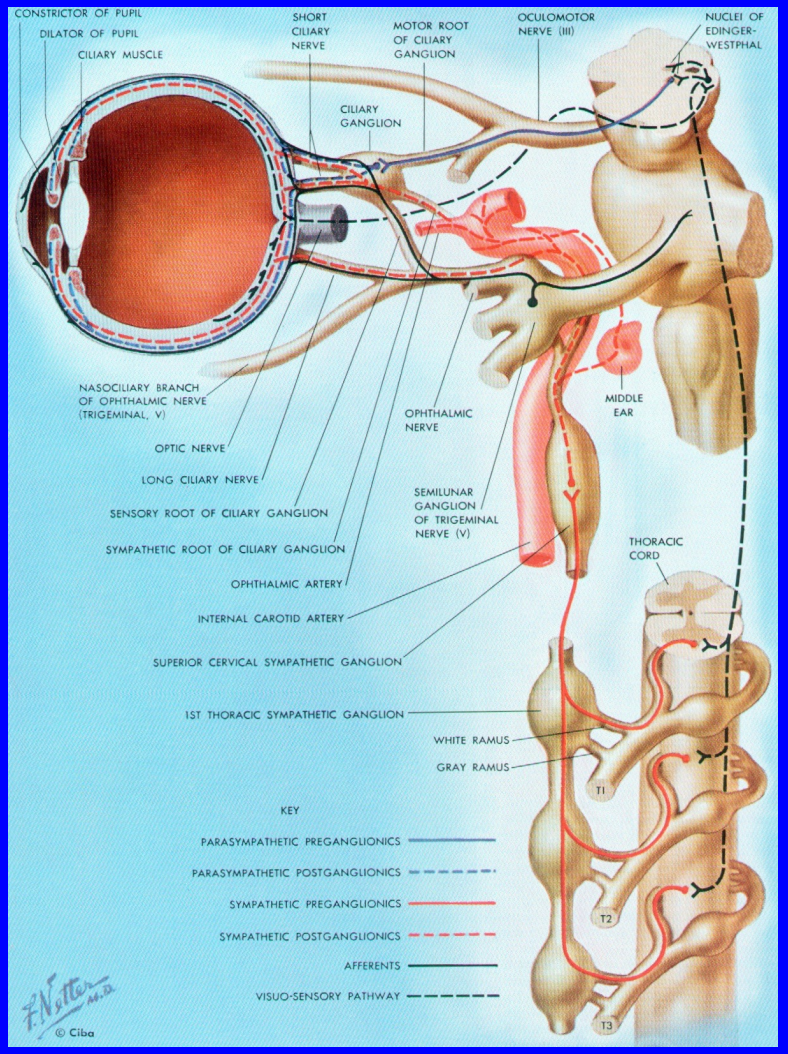
There are two divisions of the parasympathetic nervous system - cranial and sacral. The *cranial division* originates in the visceral nuclei of the midbrain, pons, and medulla. They lie in close proximity to the somatic afferent nuclei and include the Edinger-Westphal nucleus, superior and inferior salivatory nuclei, dorsal motor nucleus of the vagus, and adjacent reticular nuclei.



THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION

The Parasympathetic Nervous System

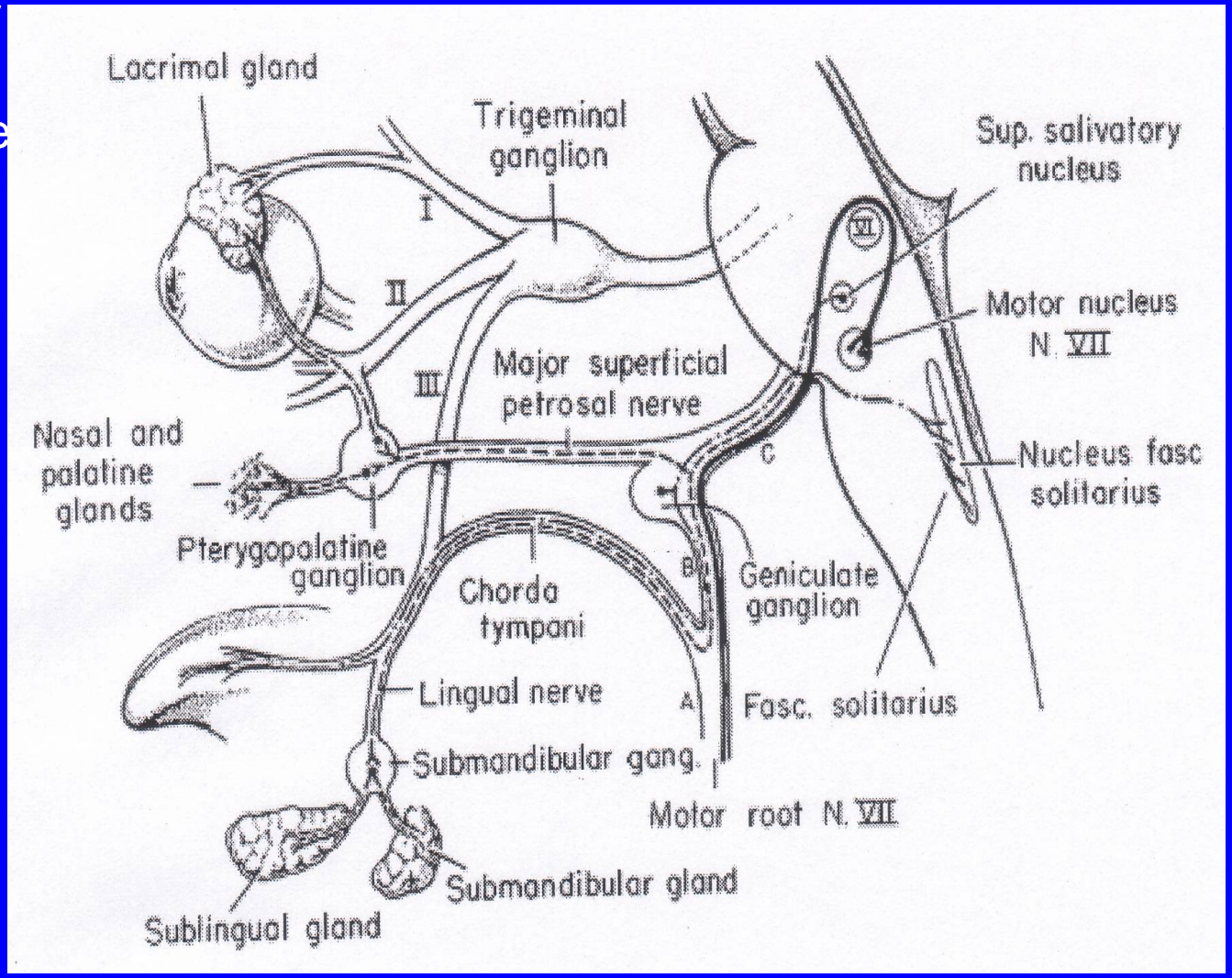
Axons (preganglionic fibers) of the visceral nuclei course through the oculomotor, facial, glossopharyngeal, and vagal nerves. The preganglionic fibers from the Edinger-Westphal nucleus run in the oculomotor nerve and synapse in the ciliary ganglion in the orbit; axons of the ciliary ganglion cells innervate the ciliary muscle and sphincter pupillae



THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION

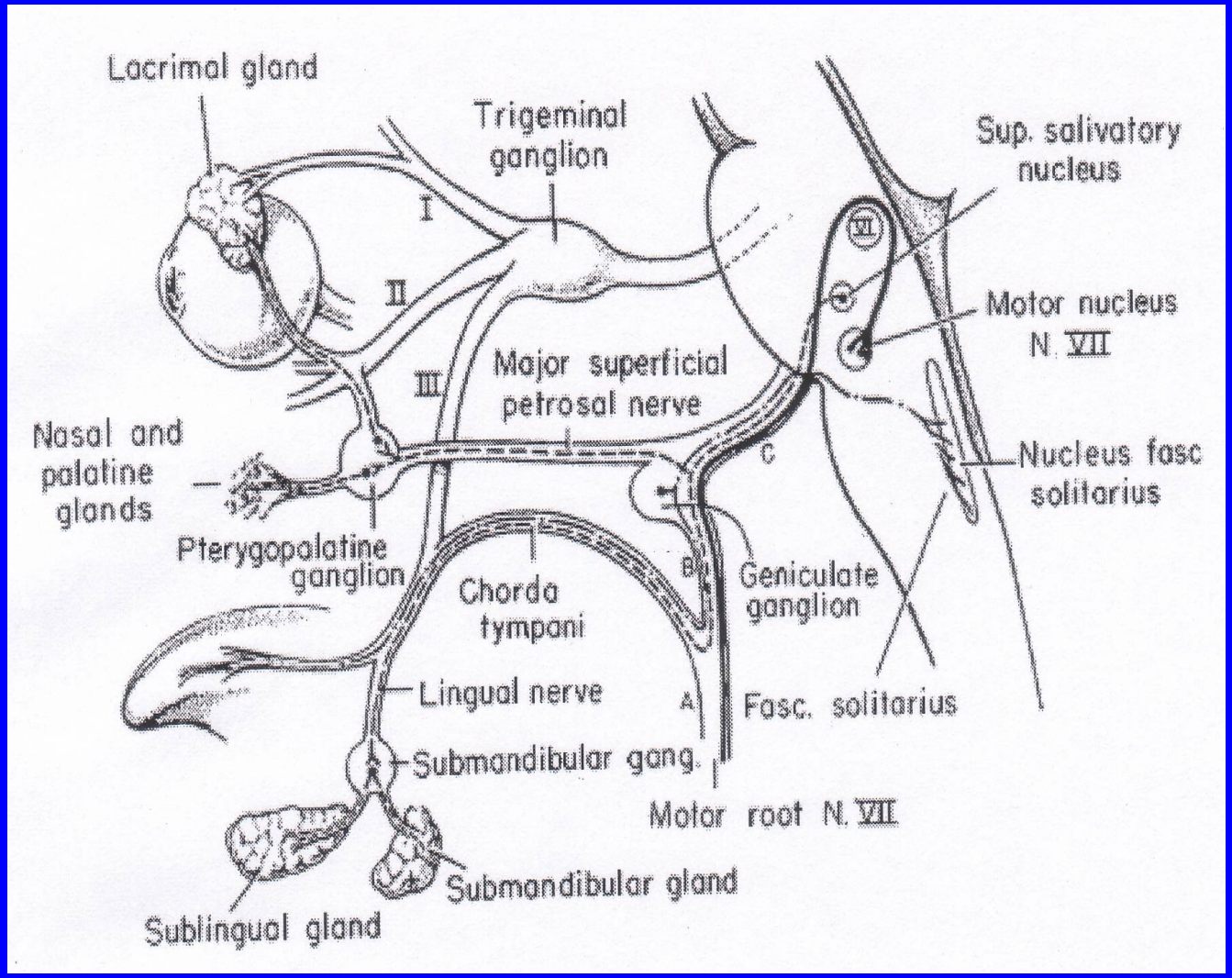
The Parasympathetic Nervous System

The preganglionic fibers of the superior salivatory nucleus enter the facial nerve and, at a point near the geniculate ganglion, form the greater superficial petrosal nerve, through which they reach the sphenopalatine ganglion; postganglionic fibers from the cells of this ganglion innervate the lacrimal gland



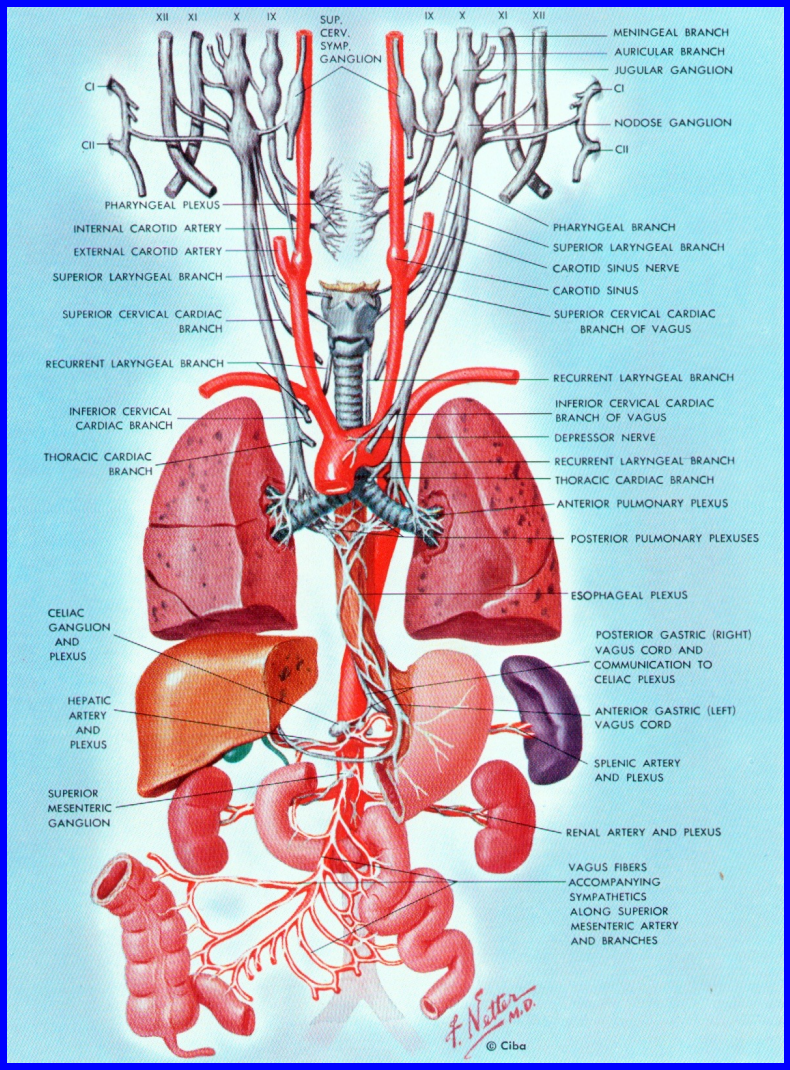
THE AUTONOMIC NERVOUS SYSTEM ANATOMIC AND PHYSIOLOGIC CONSIDERATION The Parasympathetic Nervous System

Other fibers of the facial nerve traverse the tympanic cavity as the chorda tympani and eventually join the submandibular ganglion; cells of this ganglion innervate the submandibular and sublingual glands.



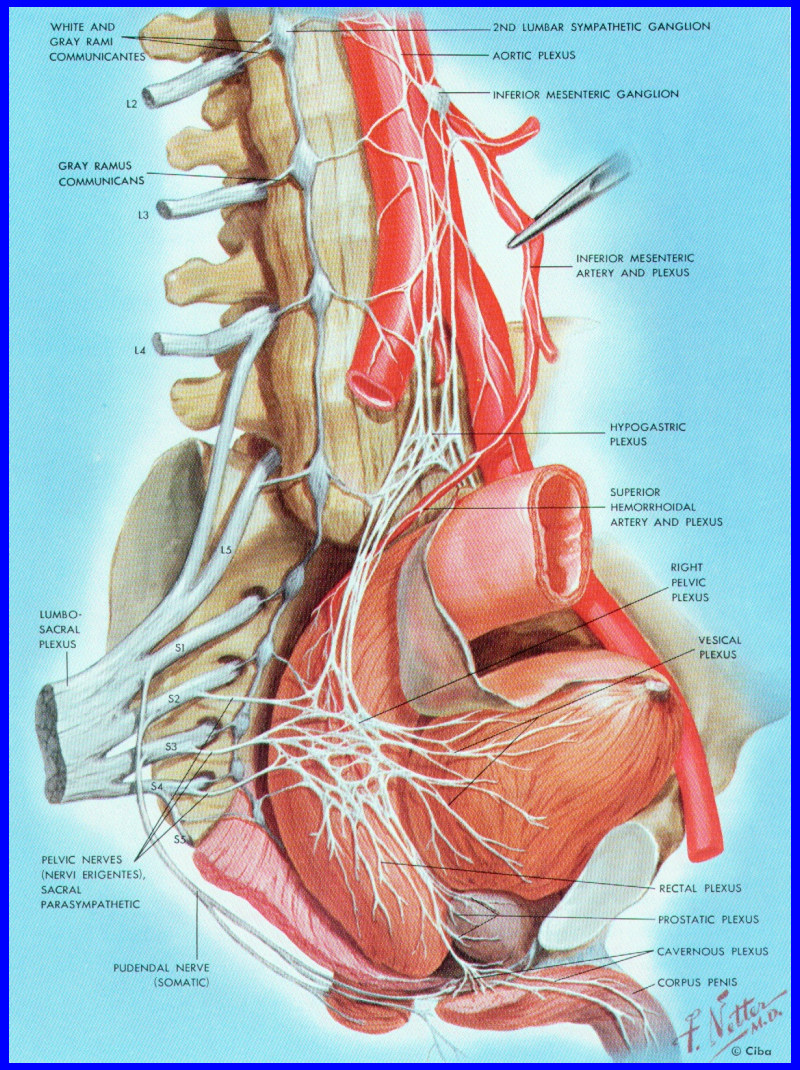
THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION
The Parasympathetic Nervous System

Preganglionic fibers, derived from the dorsal motor nucleus and adjacent visceral nuclei in the lateral reticular formation, enter the vagus nerve and terminate in ganglia situated in the walls of the many thoracic and abdominal viscera: heart, pancreas, liver, gallbladder, kidney, and ureter.



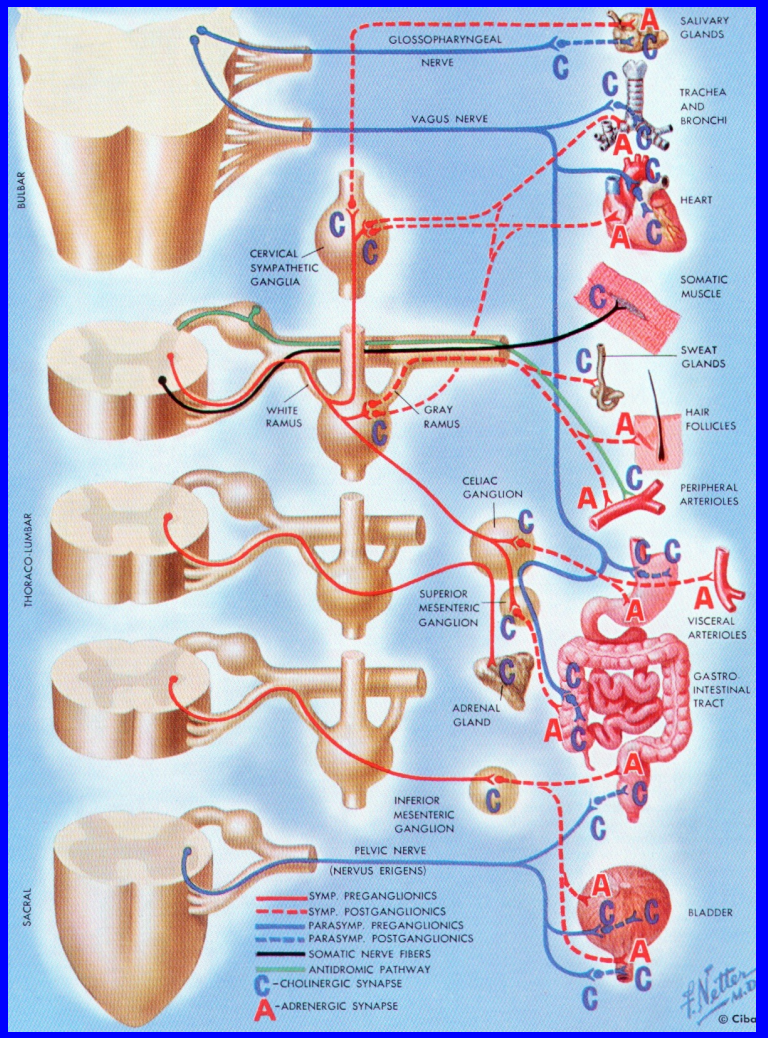
THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION
The Parasympathetic Nervous System

The *sacral part of the parasympathetic system* originates in the lateral horn cells of the second, third, and fourth sacral segments. Axons of these sacral neurons, constituting the preganglionic fibers, traverse the sacral nerves and synapse in ganglia that lie within the walls of the distal colon, bladder, and other pelvic organs. Thus, the sacral autonomic neurons, like the cranial ones, have long preganglionic and short postganglionic fibers, a feature that permits a circumscribed influence upon the target organ.



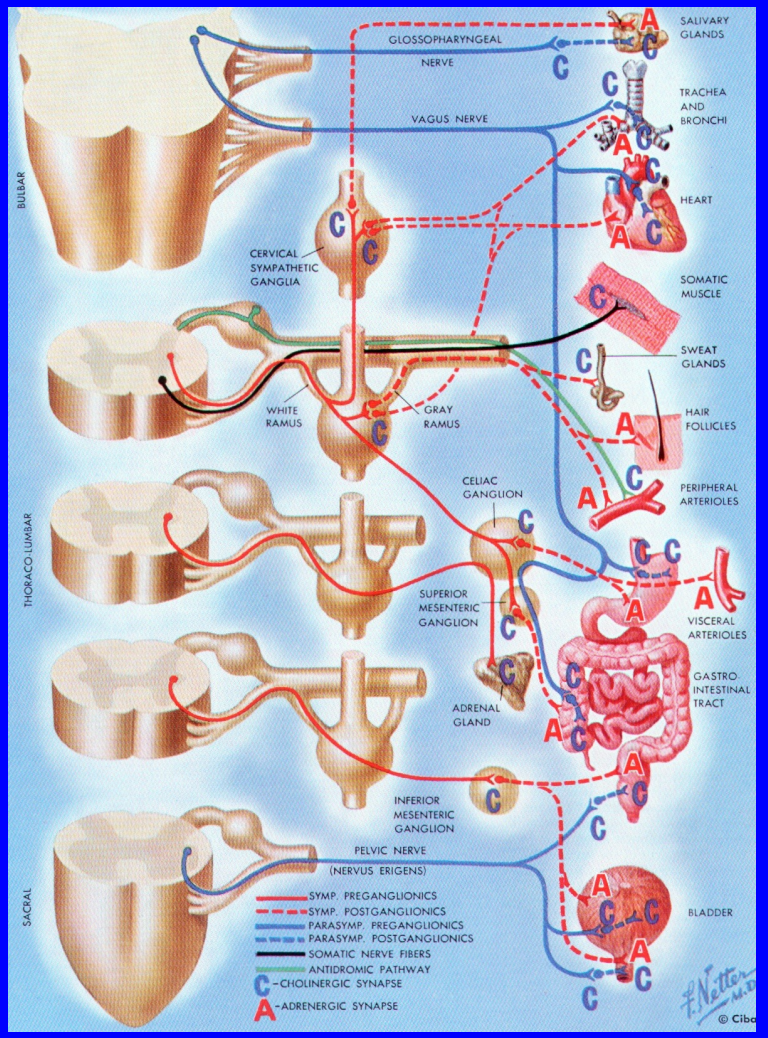
THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION
The Sympathetic Nervous System

The *preganglionic neurons of the sympathetic division originate* in the intermediolateral cell column of the spinal gray matter, from the eighth cervical to the second lumbar segments.



THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION
The Sympathetic Nervous System

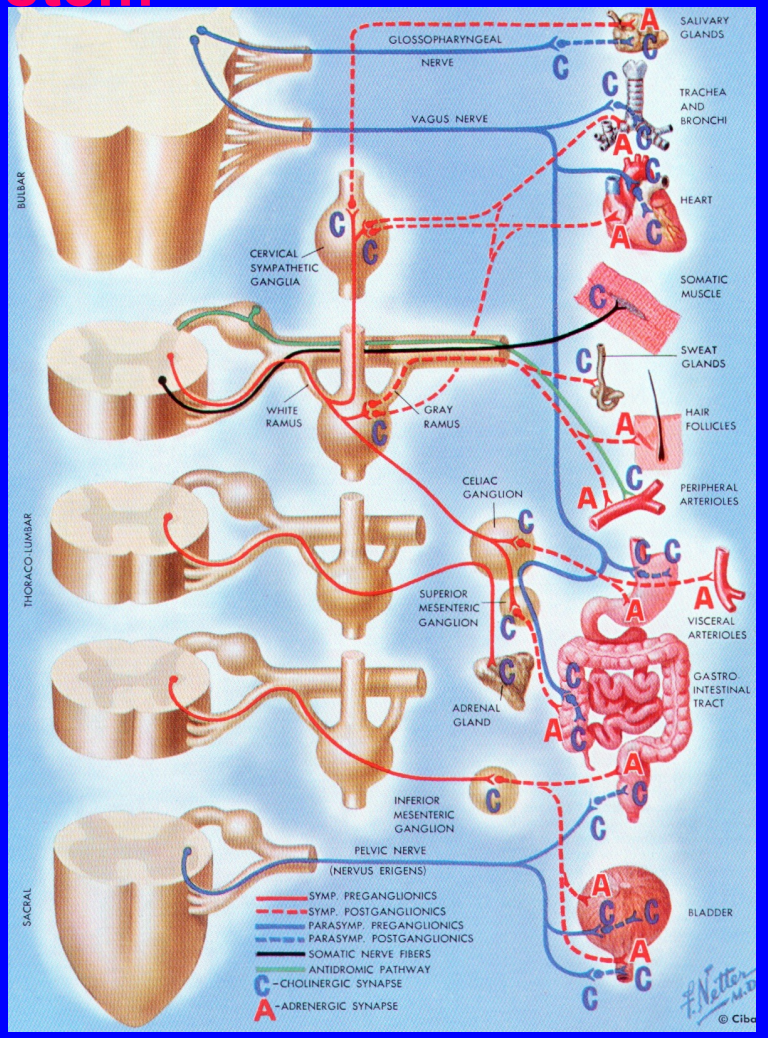
Axons of the nerve fibers originating in the intermediolateral column are of small caliber and are myelinated; when grouped, they form the *white communicating rami.* These preganglionic fibers synapse with the cell bodies of the postganglionic neurons, which are collected into two large ganglionated chains or cords, one on each side of the vertebral column (paravertebral ganglia), and several single prevertebral ganglia.



THE AUTONOMIC NERVOUS SYSTEM
ANATOMIC AND PHYSIOLOGIC CONSIDERATION

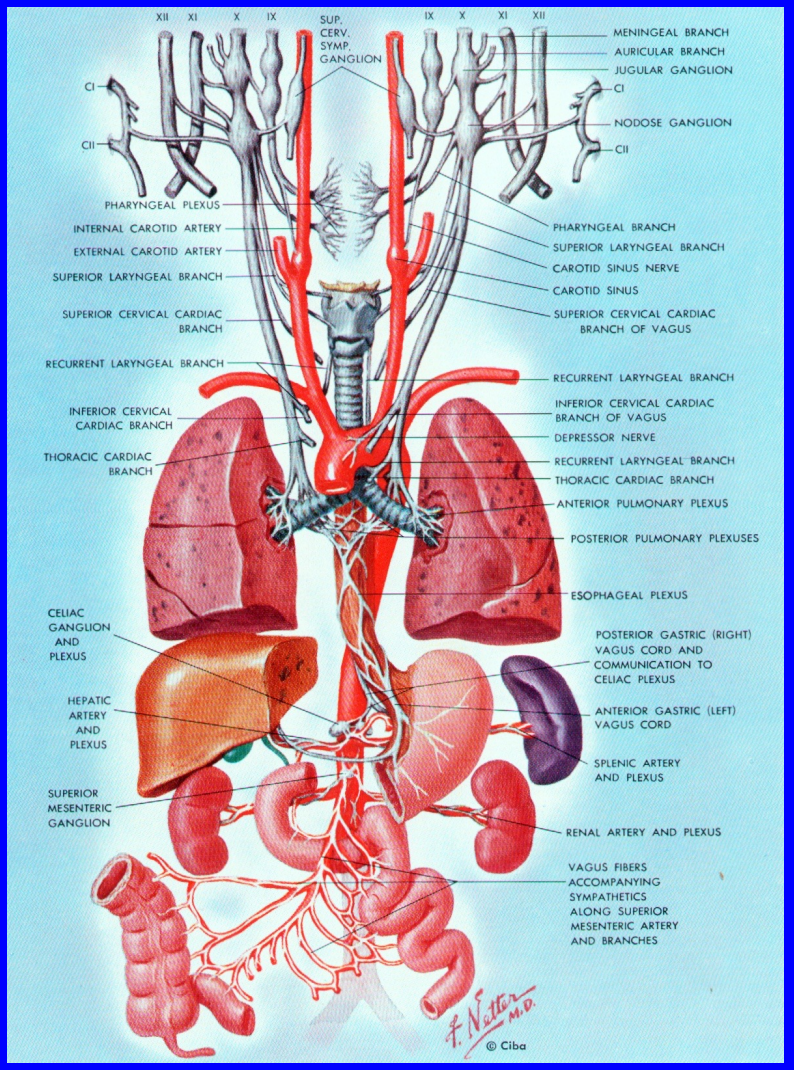
The Sympathetic Nervous System

Axons of the sympathetic ganglion cells are also of small caliber but are unmyelinated. Most of the postganglionic fibers pass via *gray communicating rami* to spinal nerves; they supply the blood vessels, sweat glands, and hair follicles and also form plexuses that supply the heart, bronchi, kidneys, intestines, pancreas, bladder, and sex organs. The postganglionic fibers of the prevertebral ganglia form the hypogastric, splanchnic, and mesenteric plexuses, which innervate the glands, smooth muscle, and blood vessels of the abdominal and pelvic viscera



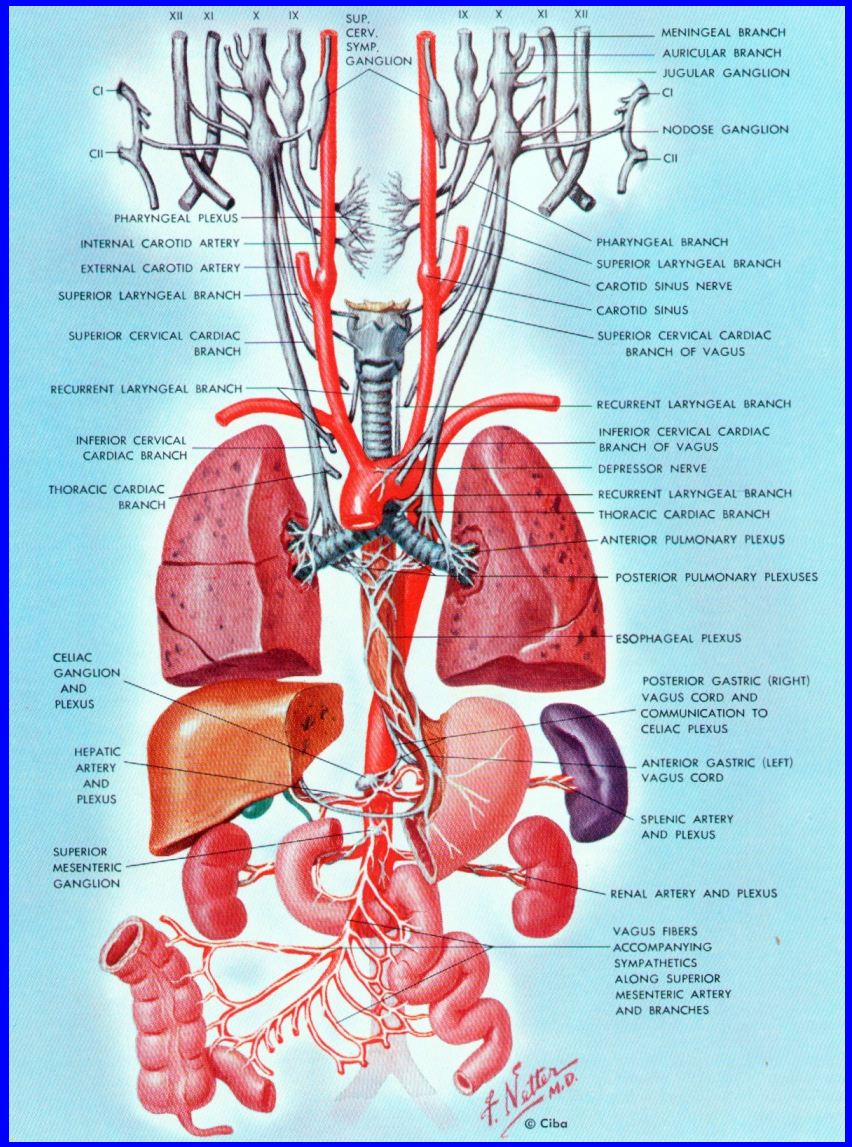
THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

The function of the autonomic nervous system is to regulate the activities of a group of organs, mainly visceral ones, that possess a high degree of independence. When the autonomic nerves are interrupted, these organs continue to function (the organism survives), but no longer can they effectively maintain homeostasis and adapt to the demands of changing internal conditions and external stresses



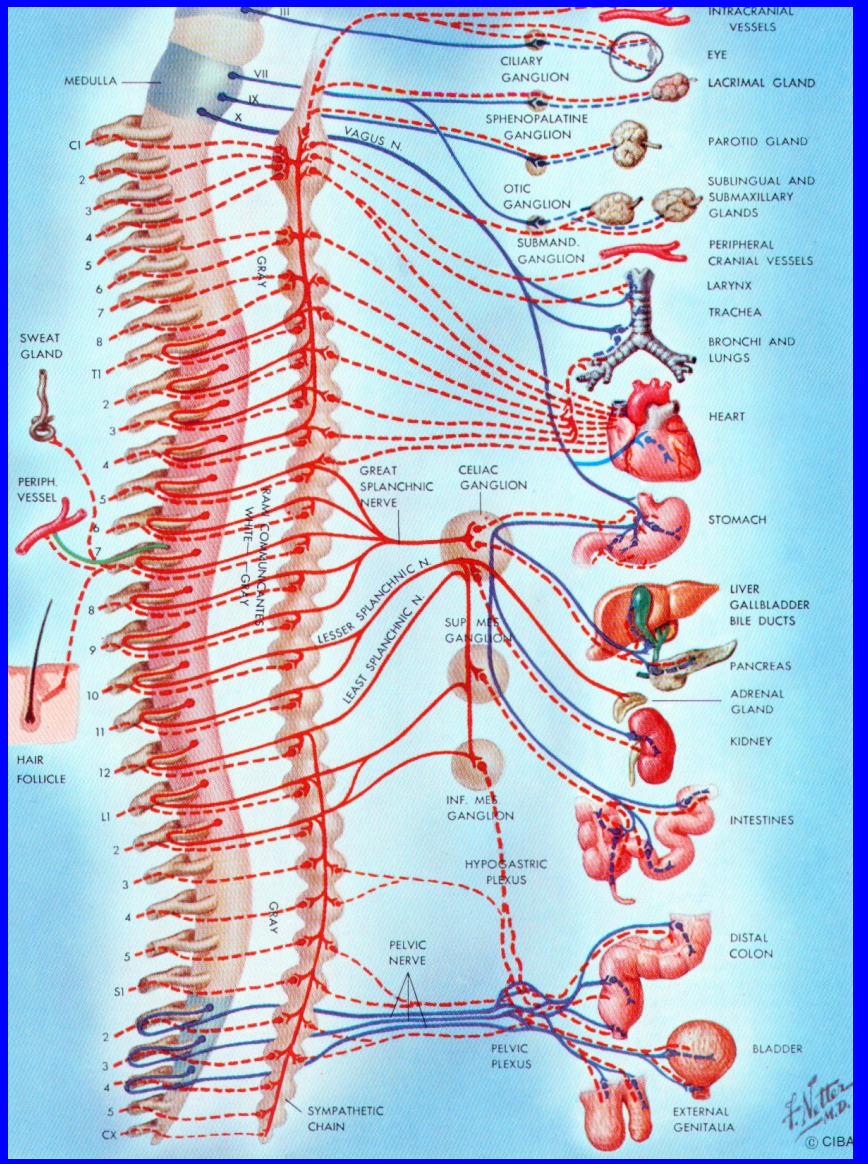
THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

It was learned long ago that most viscera have a double nerve supply, sympathetic and parasympathetic, and that in general these two parts of the autonomic nervous system exert opposite effects. For example, the effects of the sympathetic nervous system on the heart are excitatory and those of the parasympathetic, inhibitory. However, some structures - sweat glands, somatic blood vessels, and hair follicles - receive only sympathetic postganglionic fibers, and the adrenal gland, as indicated above, has only a preganglionic sympathetic innervation. Also, some parasympathetic neurons have been identified in sympathetic ganglia.



THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

All autonomic functions are mediated through the release of chemical transmitters, the most important of which are acetylcholine (ACh) and norepinephrine (NE). Acetylcholine is synthesized at the terminals of axons and stored in presynaptic vesicles until released by the arrival of nerve impulses. Indeed, the concept of neurohumoral transmission was first validated through studies of the action of acetylcholine in the parasympathetic nerves



THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

Acetylcholine is also the chemical transmitter of nerve impulses to the skeletal muscle fibers. The arrival of nerve impulses releases ACh, which traverses the synaptic cleft and attaches to receptor sites on the next neuron, smooth or striated muscle cell, or glandular cell. There are two distinct types of ACh receptors - *nicotinic* and *muscarinic*, so named by Dale because the choline-induced responses were similar either to those of nicotine or to those of the alkaloid muscarine. The postganglionic parasympathetic receptors are muscarinic, i.e., they are antagonized by atropinic drugs. The receptors in ganglia, like those of skeletal muscle, are not blocked by atropine (i.e., the nicotinic effect) but are blocked by other agents, e.g., tubocurarine.

THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

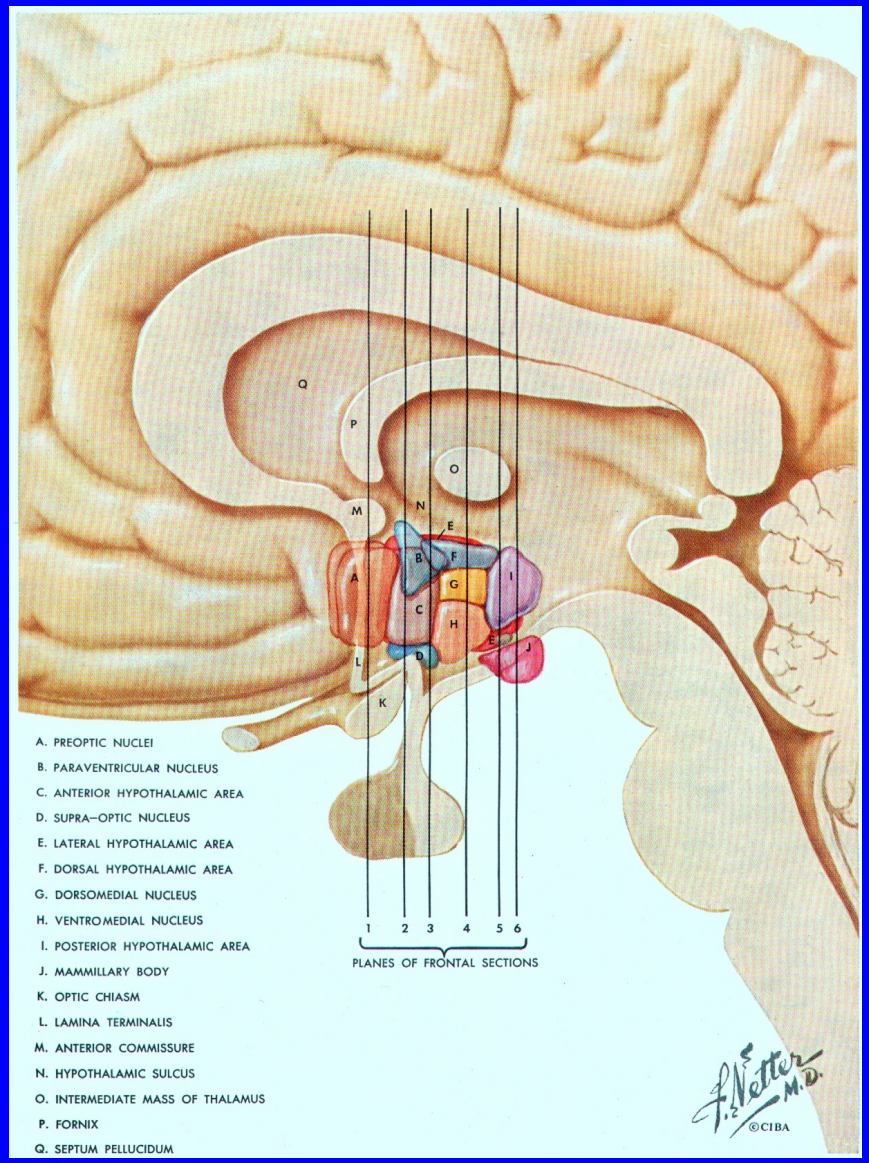
It is likely that more than ACh is involved in nerve transmission at a ganglionic level. Many peptides - substance P, enkephalins, somatostatin, vasoactive intestinal peptide, and most recently nitric oxide - have been identified in the autonomic ganglia, localizing in some cases to the same cell as ACh. The neuropeptides are contained in small, intensely fluorescent cells and probably act as modulators at transmitter sites, although their exact function in many cases remains to be determined.

THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

Adrenergic receptors are of two types, classified originally by Ahlquist as alpha and beta. In general, the alpha receptors mediate vasoconstriction, relaxation of the gut, and dilatation of the pupil; beta receptors mediate vasodilatation, especially in muscles, relaxation of the bronchi, and an increased rate and contractility of the heart. Each of these receptors is subdivided further into two types. Alpha1 receptors are postsynaptic; alpha2 receptors are presynaptic and, when stimulated, diminish the release of the transmitter. Beta1 receptors are, for all practical purposes, limited to the heart, and their activation increases the heart rate and contractility. Beta2 receptors, when stimulated, relax the smooth muscle of the bronchi and at most other sites

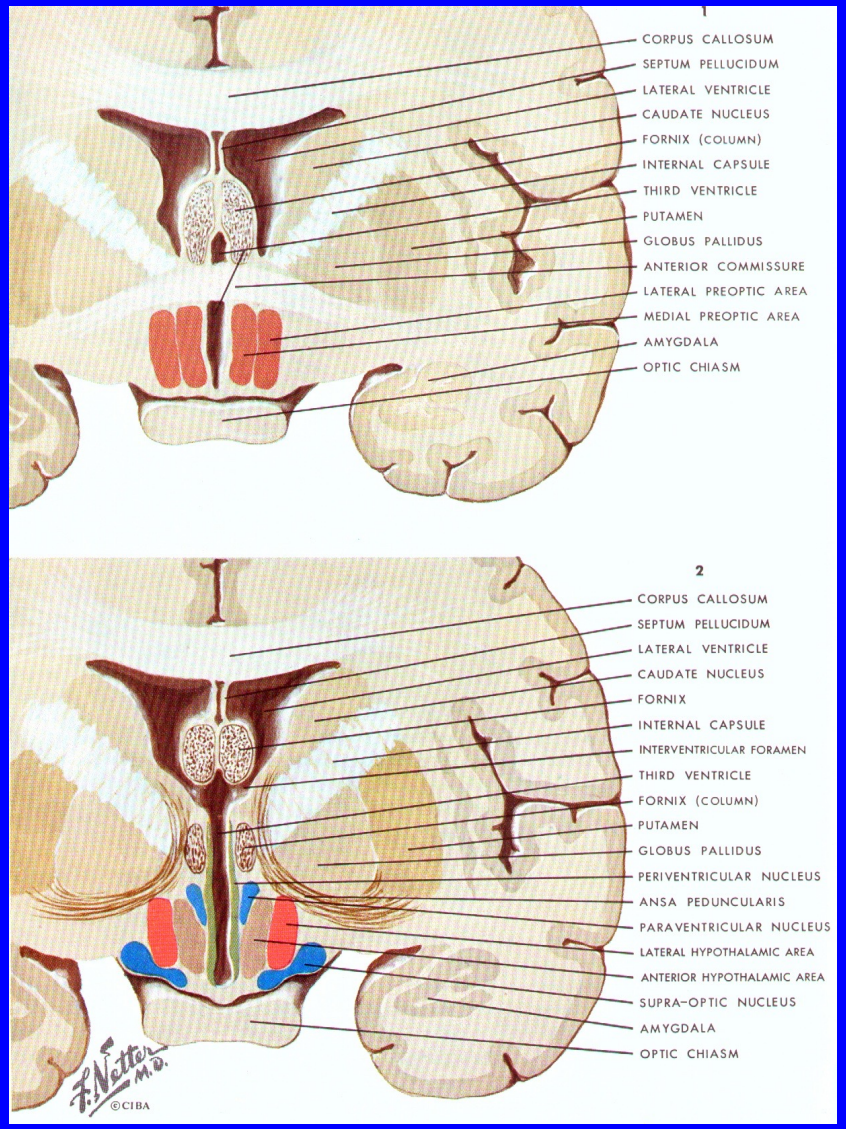
THE AUTONOMIC NERVOUS SYSTEM
Physiologic and Pharmacologic Considerations

The two divisions of the autonomic nervous system acting in conjunction with the endocrine glands maintain the homeostasis of the organism. The integration of these two systems is achieved primarily in the hypothalamus.



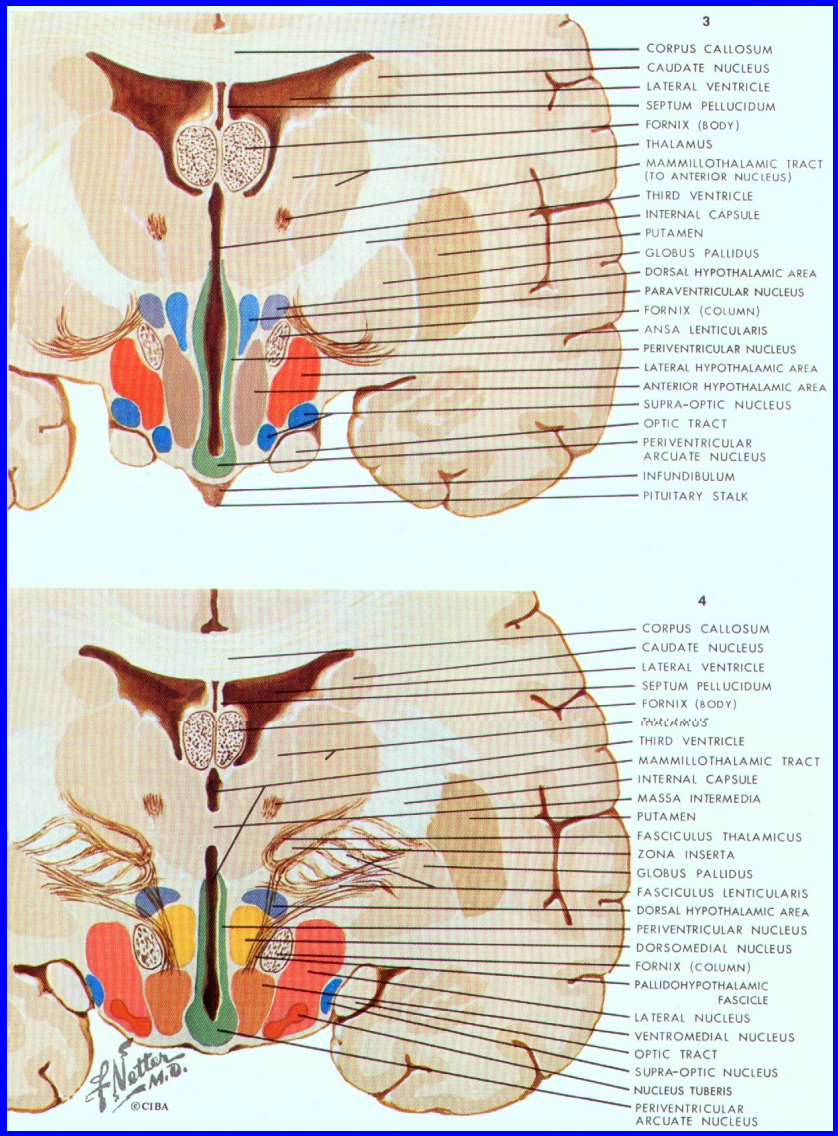
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

Among the most important advances in neuroanatomy has been the discovery of autonomic regulating mechanisms in the brain. Small, insignificant-appearing nuclei in the walls of the third ventricle (hypothalamus) and in buried parts of the limbic cortex, formerly judged to have purely olfactory functions, are now known to have rich bidirectional connections.



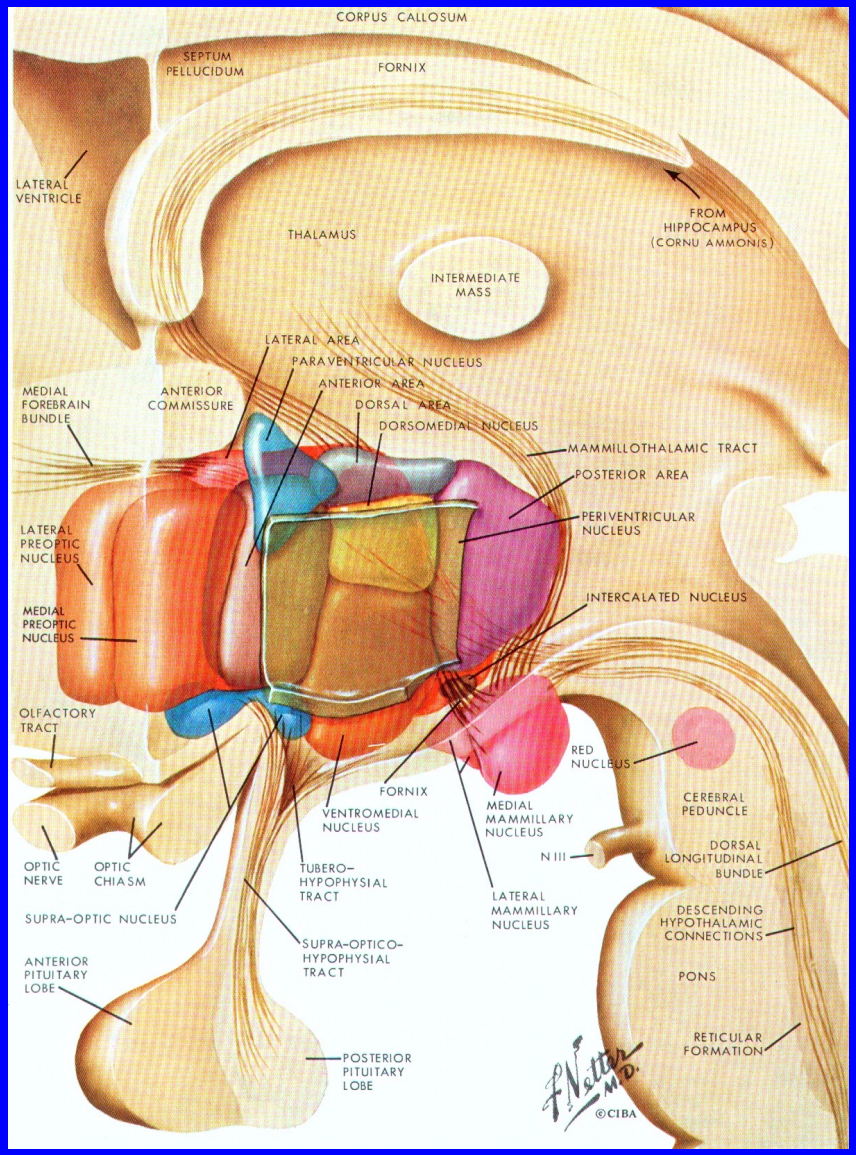
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

In fact, the hypothalamus serves as the integrating mechanism of the autonomic nervous system and limbic system



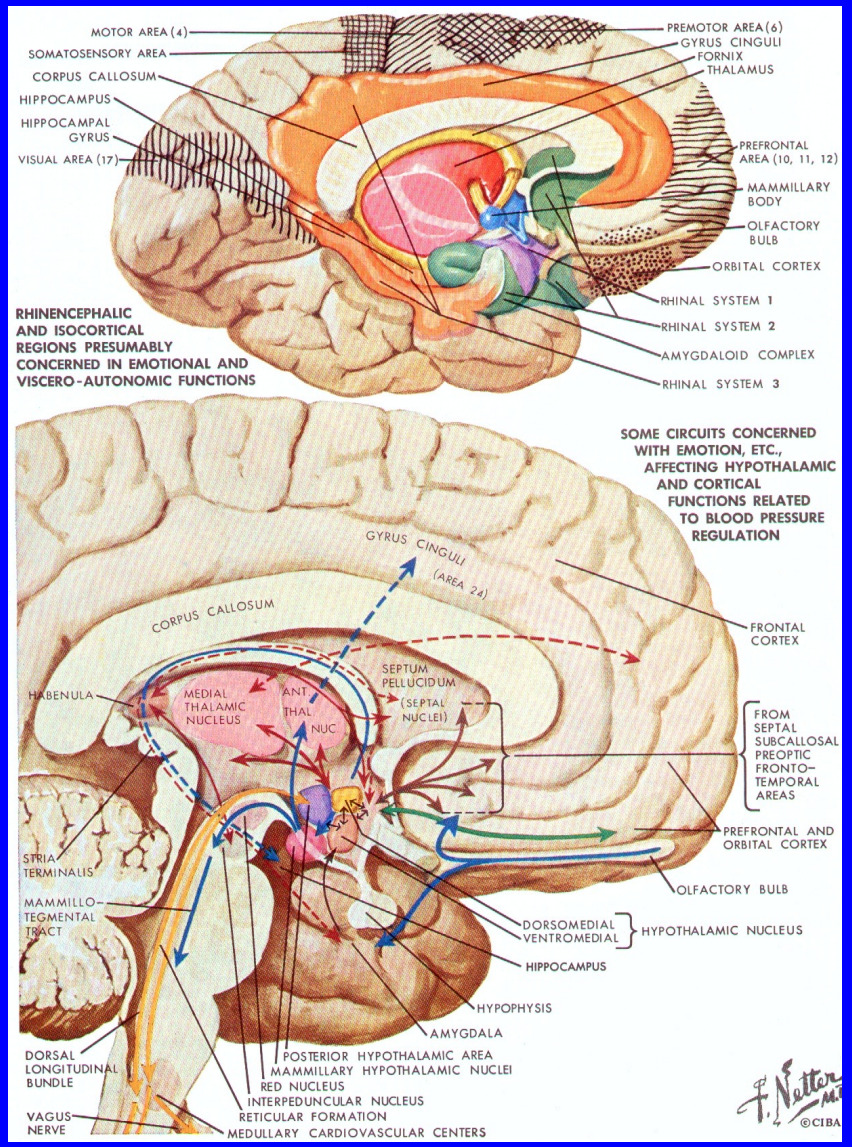
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

The regulatory activity of the hypothalamus is accomplished in two ways - through direct pathways that descend into the brainstem and spinal cord and through the pituitary and thence other endocrine glands. The supranuclear regulatory apparatus of the autonomic nervous system also includes three main structures: the frontal lobe cortex and amygdaloid and adjacent nuclei



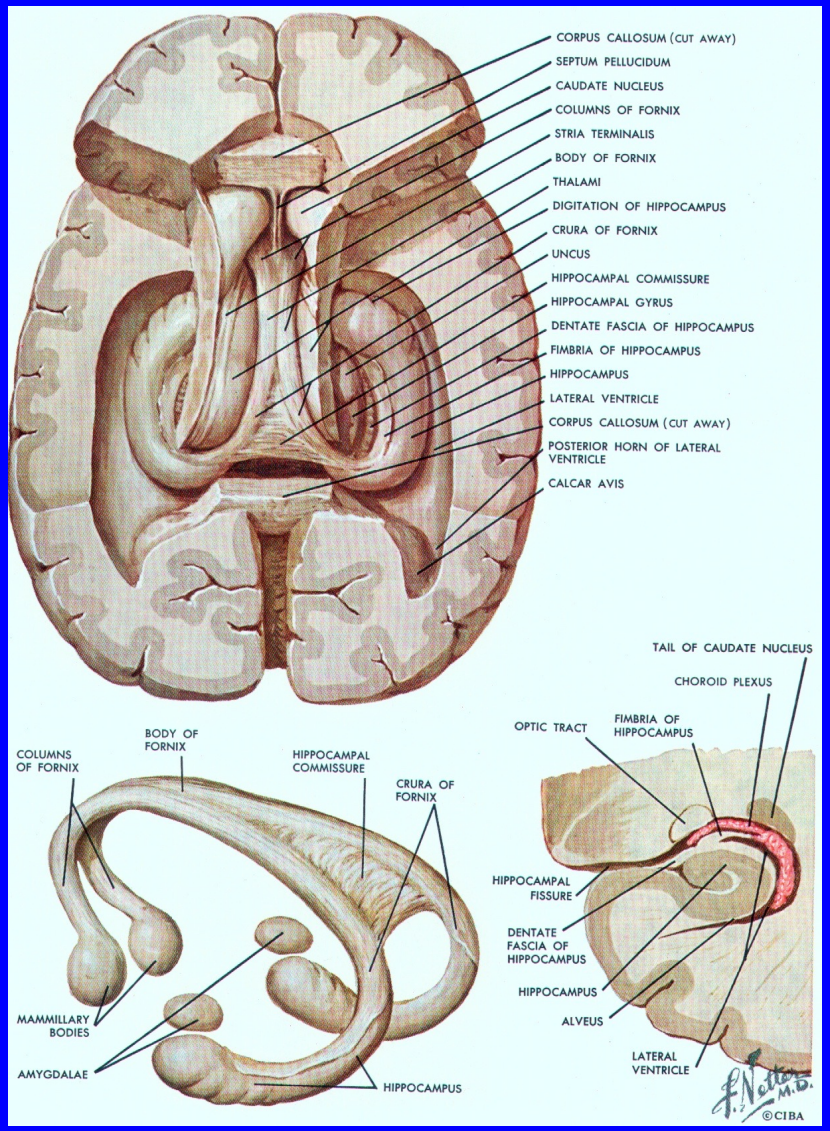
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

The *frontal lobe cortex*-the least understood and most uniquely human structure-appears to function as the highest level of integration of autonomic function. Stimulation of one frontal lobe may evoke changes in temperature and sweating in the contralateral arm and leg; massive lesions here, which usually cause a hemiplegia, may modify the autonomic functions in the direction of either inhibition or facilitation. Lesions involving the posterior part of the superior frontal and anterior part of the cingulate gyri (usually bilateral, occasionally unilateral) result in loss of voluntary control of the bladder and bowel



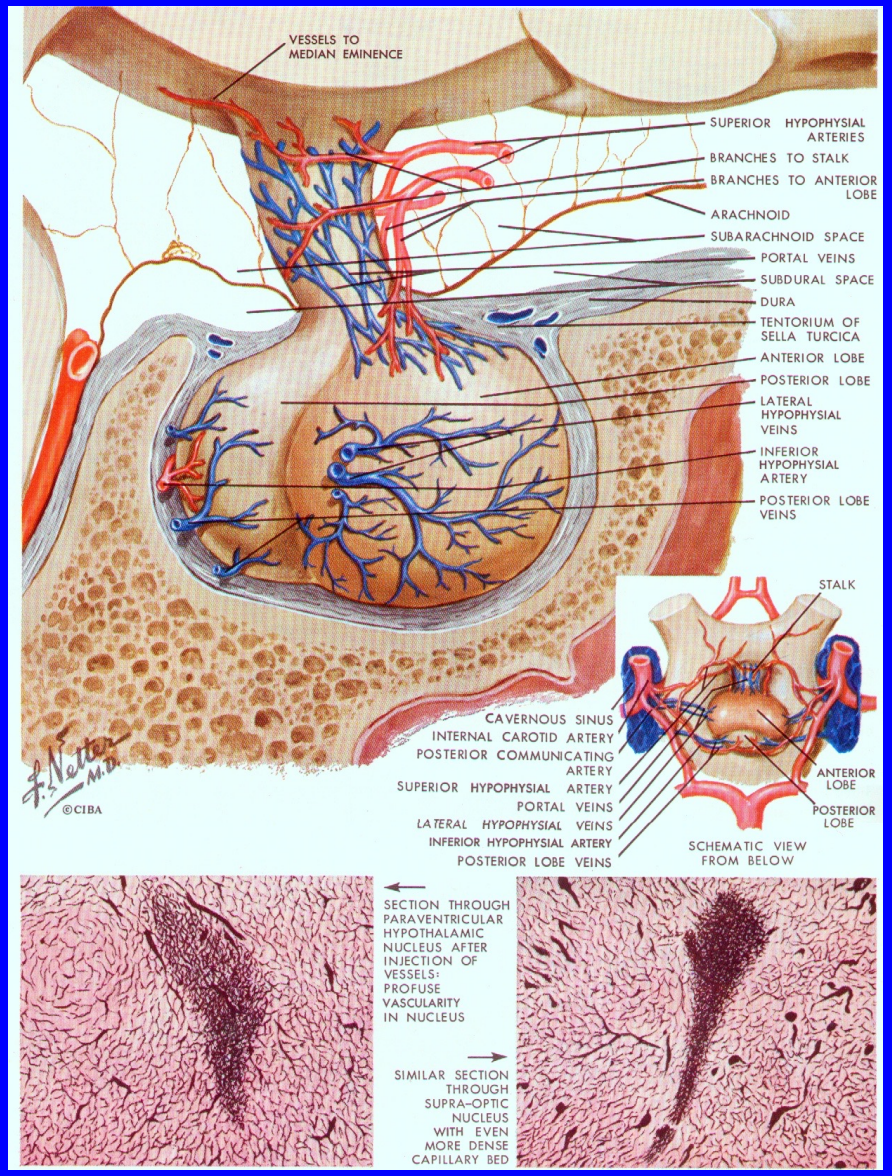
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

Most likely a large contingent of these fibers terminates in the hypothalamus, which, in turn, sends fibers to the brainstem and spinal cord. The descending spinal pathways are believed to lie ventromedial to the corticospinal fibers.



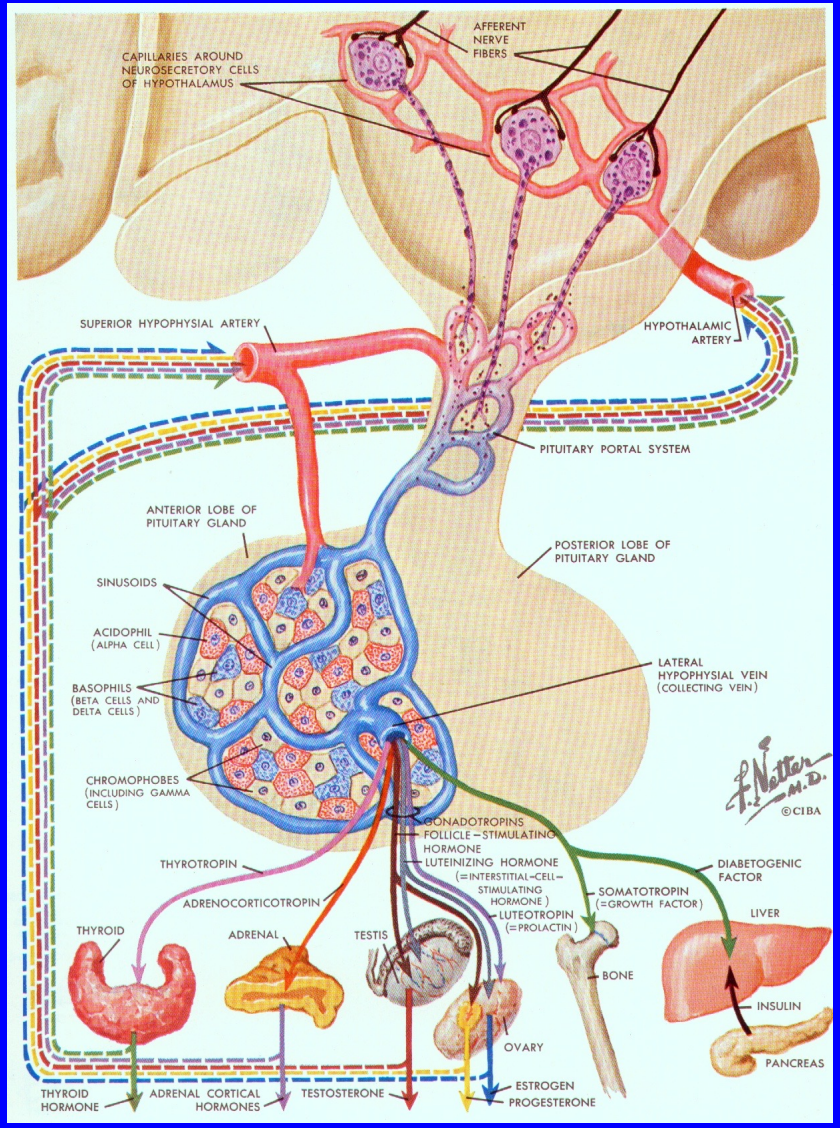
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

The archicortex and transitional mesocortex, including the cingulate and hippocampal gyri and their associated subcortical structures (substantia innominata and the amygdaloid, septal, piriform, habenular, and midbrain tegmental nuclei), have been identified as important cerebral autonomic centers. Together they have been called the *visceral brain*;



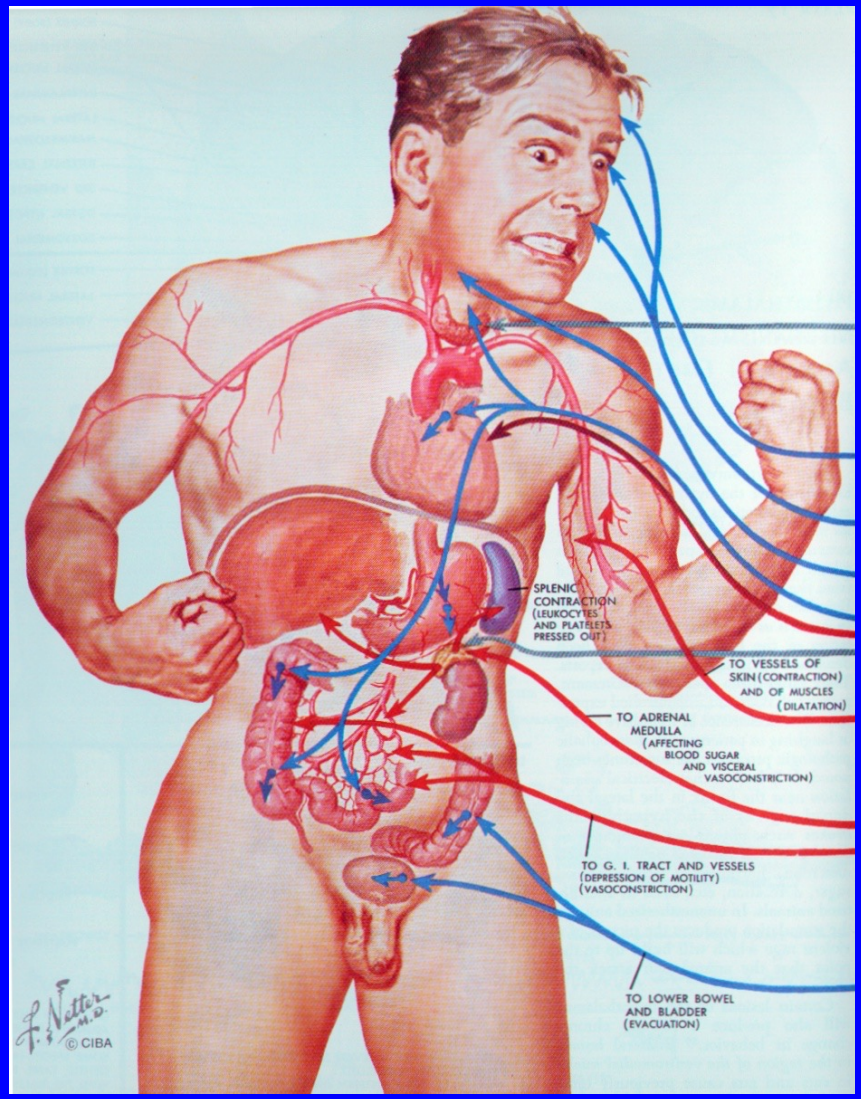
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

Of central importance in autonomic regulation is the amygdaloid group of nuclei. Electrical stimulation in or near these nuclei in the unanesthetized cat yields a variety of motor and vegetative responses. One of these has been referred to as the *fear*, or *flight*,



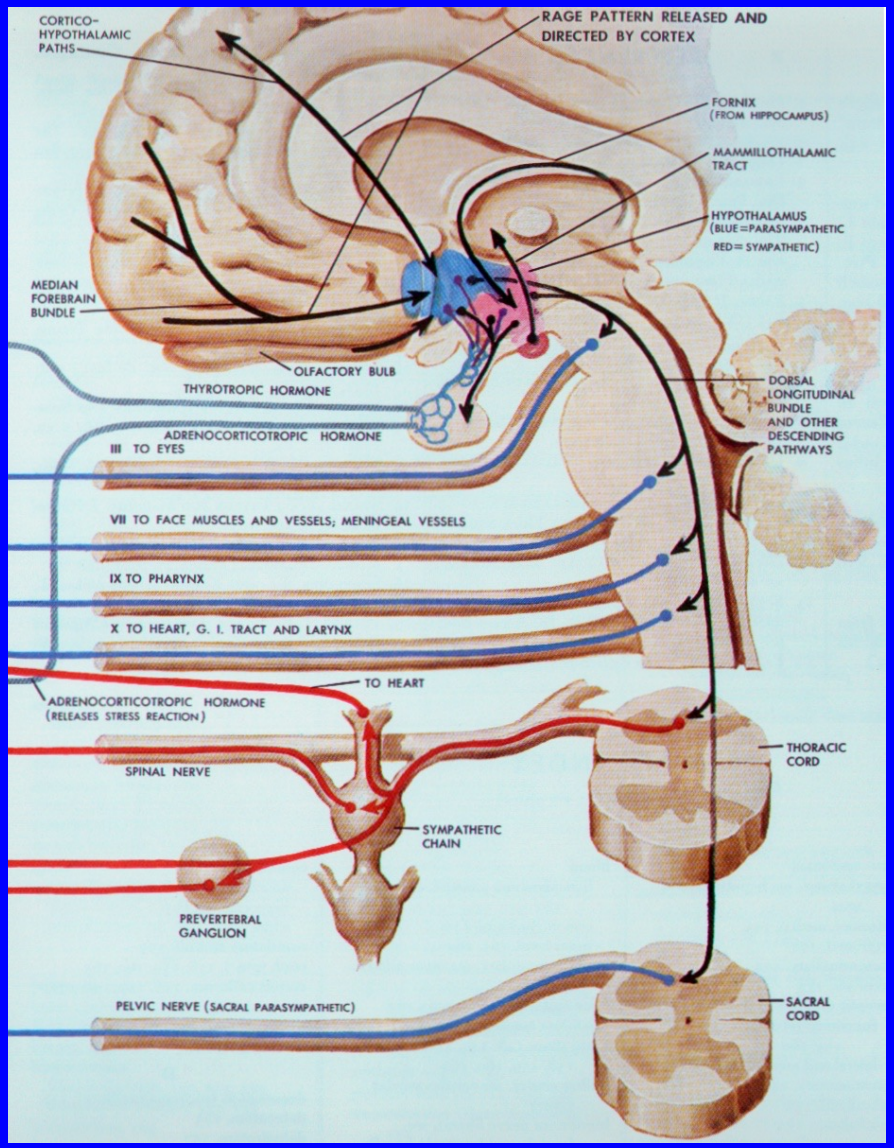
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

Lesions in the ventromedial nuclei of the hypothalamus (which receive an abundant projection of fibers from the amygdaloid nuclei via the stria medullaris) have been shown to cause aggressive behavior, and bilateral ablation of neocortical area 24 (rostral cingulate gyrus) has produced the opposite state-tameness and reduced aggressiveness, at least in some species.



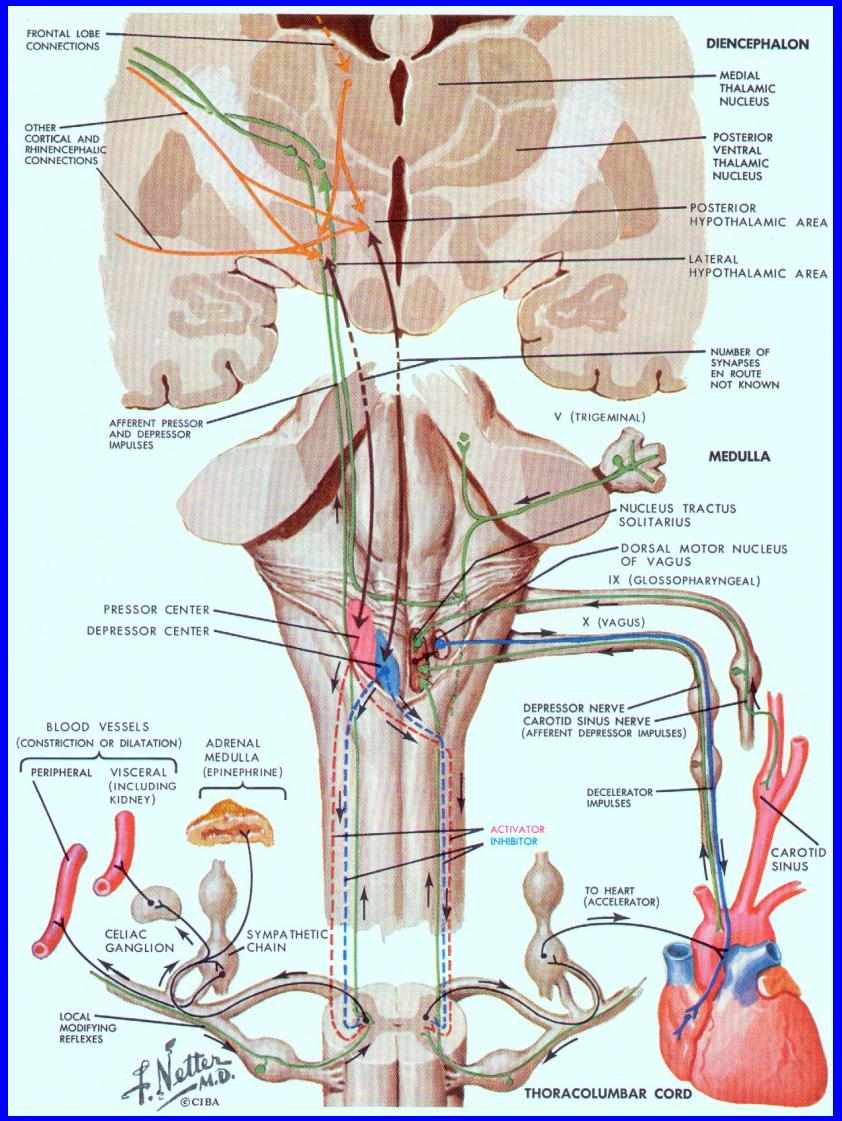
THE AUTONOMIC NERVOUS SYSTEM
The Central Regulation of Visceral Function

Finally, the central role of the hypothalamus in the initiation and regulation of autonomic activity is now generally recognized. Sympathetic responses are most readily obtained by stimulation of the posterior and lateral regions of the hypothalamus, and parasympathetic responses, from the anterior regions.



THE AUTONOMIC NERVOUS SYSTEM
Vasovagal Reaction

Many number of stimuli can elicit the vasovagal response, including psychic ones such as fear, other extreme emotion, the sight of blood, glossopharyngeal nerve stimulation, carotid sinus pressure, and perhaps micturition and coughing.

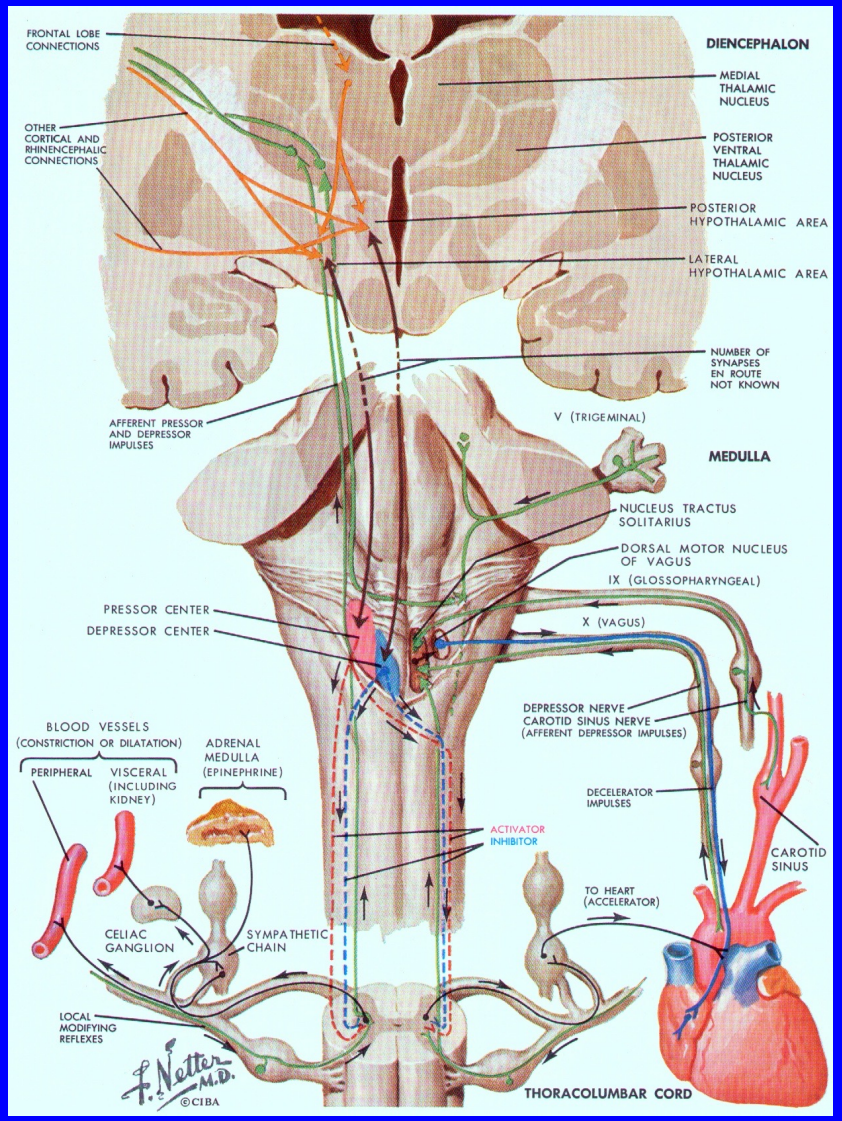


THE AUTONOMIC NERVOUS SYSTEM

Tests for Abnormalities of the Autonomic Nervous System

Responses of Blood Pressure and Heart Rate to Changes in Posture and Breathing

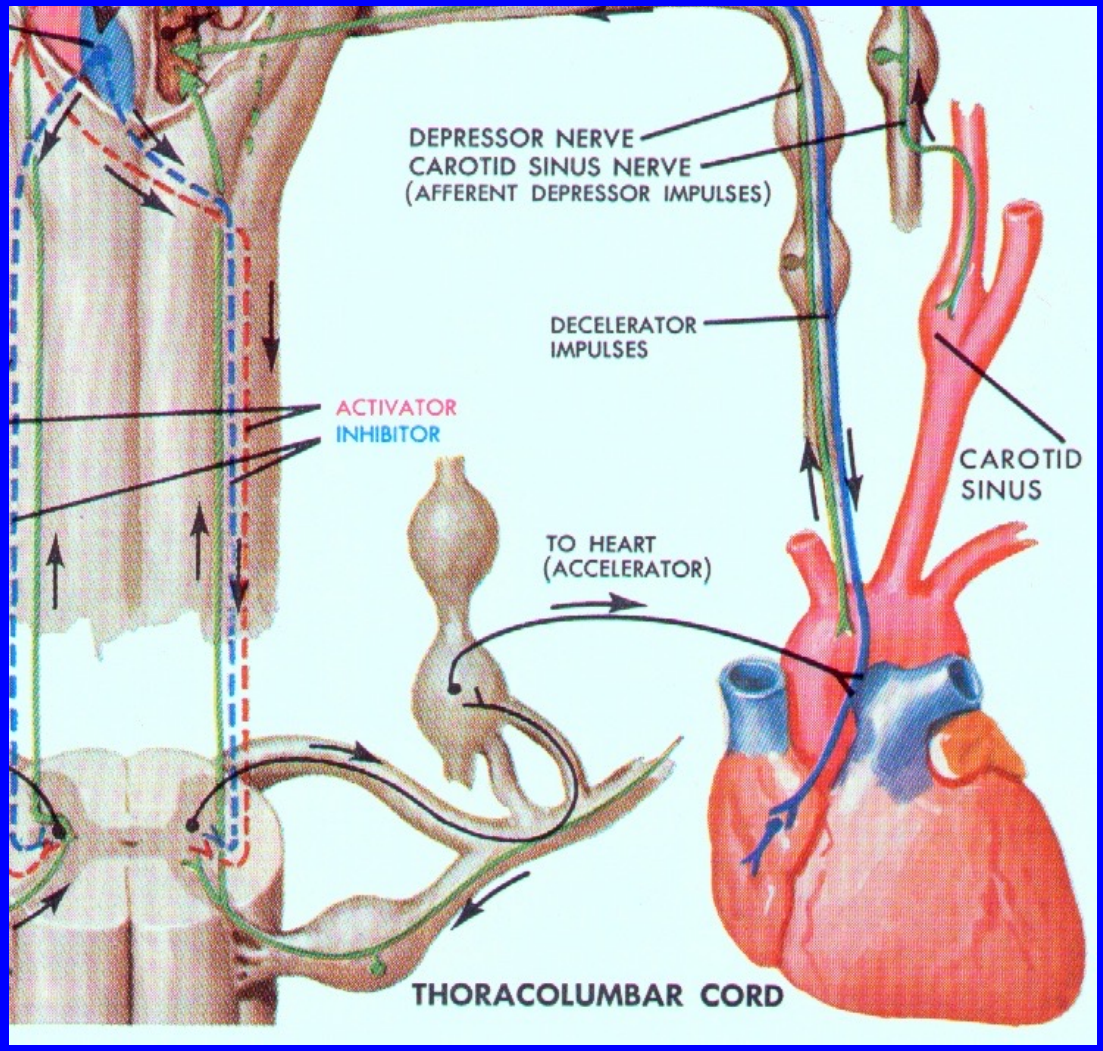
changing from the recumbent to the standing position, a fall of more than 30 mmHg systolic and 15 mmHg diastolic is abnormal;



THE AUTONOMIC NERVOUS SYSTEM

Tests for Abnormalities of the Autonomic Nervous System

variation in heart rate during deep breathing (respiratory sinus arrhythmia). The ECG is recorded while the patient first breathes at a regular rate of 6 to 12 per minute. Normally, the heart rate varies by as many as 15 beats per minute or even more; differences of less than 10 beats per minute may be abnormal

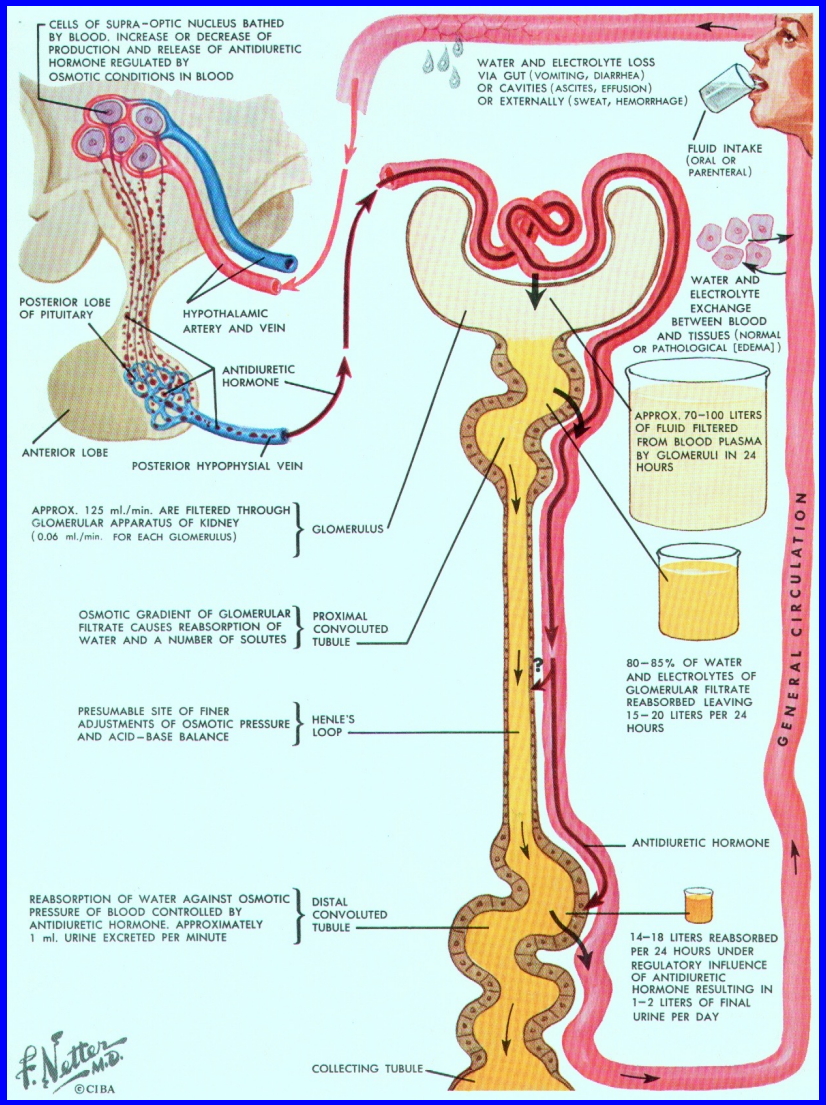


THE AUTONOMIC NERVOUS SYSTEM

Tests for Abnormalities of the Autonomic Nervous System

Tests of Vasomotor Reactions

Measurement of the skin temperature is a useful index of vasomotor function. Vasomotor paralysis results in vasodilatation of skin vessels and a rise in temperature; vasoconstriction lowers the temperature. With a skin thermometer, one may compare affected and normal areas under standard conditions. The normal skin temperature is 31 to 33° C when the room temperature is 26 to 27° C

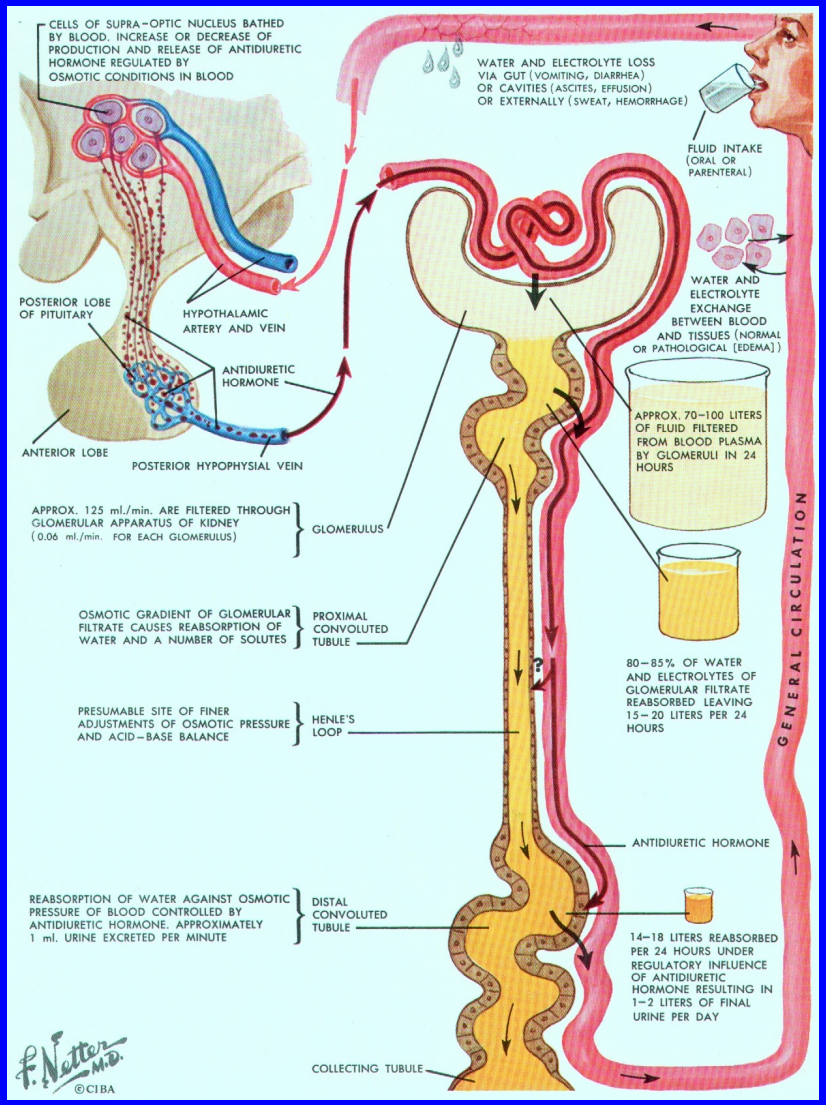


THE AUTONOMIC NERVOUS SYSTEM

Tests for Abnormalities of the Autonomic Nervous System

Tests of Sudomotor Function

Sweat can be weighed after it is absorbed by small squares of filter paper. Powdered charcoal dusted on the skin will cling to moist areas and not to dry ones.



THE AUTONOMIC NERVOUS SYSTEM
CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Complete Autonomic Paralysis (Dysautonomic Polyneuropathy; Pure Pandysautonomia)

The patient develops some combination of anhidrosis, orthostatic hypotension, paralysis of pupillary reflexes, loss of lacrimation and salivation, impotence, impaired bladder and bowel function (urinary retention, postprandial bloating and ileus or constipation), and loss of certain pilomotor and vasomotor responses in the skin (flushing and heat intolerance). Severe fatigue is a prominent complaint in most patients, and abdominal pain and vomiting in others. A few have developed sleep apnea or the syndrome of excessive antidiuretic hormone secretion (hyponatremia). The CSF protein is normal or slightly increased. Clinical and laboratory findings indicate that both the sympathetic and parasympathetic parts of the autonomic nervous system are affected, mainly at the postganglionic level

THE AUTONOMIC NERVOUS SYSTEM
CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Peripheral Neuropathy with Secondary Orthostatic Hypotension

Impairment of autonomic function, of which orthostatic hypotension is the most serious feature, may occur as part of the more common peripheral neuropathies (Guillain-Barre, diabetic, alcoholic-nutritional, amyloid, and porphyric). Disease of the peripheral nervous system may affect the circulation in two ways: baroreceptors may be affected, interrupting normal homeostatic reflexes on the afferent side, or postganglionic sympathetic fibers may be affected in the spinal nerves. The severity of the autonomic failure need not parallel the degree of motor weakness.

THE AUTONOMIC NERVOUS SYSTEM
CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Autonomic Neuropathy in Infants and Children (Riley-Day Syndrome)

This is a familial disease inherited as an autosomal recessive trait. The main symptoms are postural hypotension and lability of blood pressure, faulty regulation of temperature, diminished hearing, hyperhidrosis, blotchiness of the skin, insensitivity to pain, emotional lability, and vomiting. There is denervation sensitivity of the pupils and other structures. A deficiency of neurons in the superior cervical ganglia and in the lateral horns of the spinal cord has been found. It is likely that this disease represents a failure of embryologic migration or formation of first- and second-order sympathetic neurons.

THE AUTONOMIC NERVOUS SYSTEM
CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Autonomic Failure in the Elderly

Orthostatic hypotension is prevalent in the elderly, so much so that norms of blood pressure and pulse changes have been difficult to establish. Caird and coworkers reported that among individuals who were above age 65 years and living at home, 24 percent had a fall of systolic blood pressure on standing of 20 mmHg; 9 percent had a fall of 30 mmHg; and 5 percent, a fall of 40 mmHg. An increased frequency of thermoregulatory impairment has been documented as well. The elderly are also more liable to develop hypothermia and, when exposed to high ambient temperature, to hyperthermia.

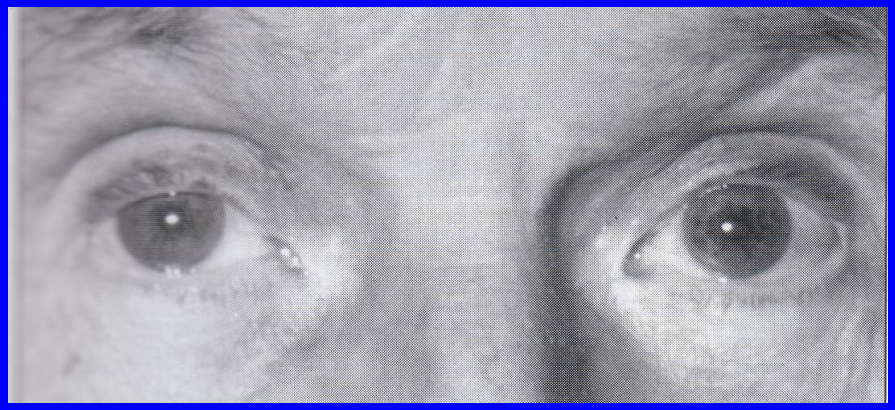
THE AUTONOMIC NERVOUS SYSTEM

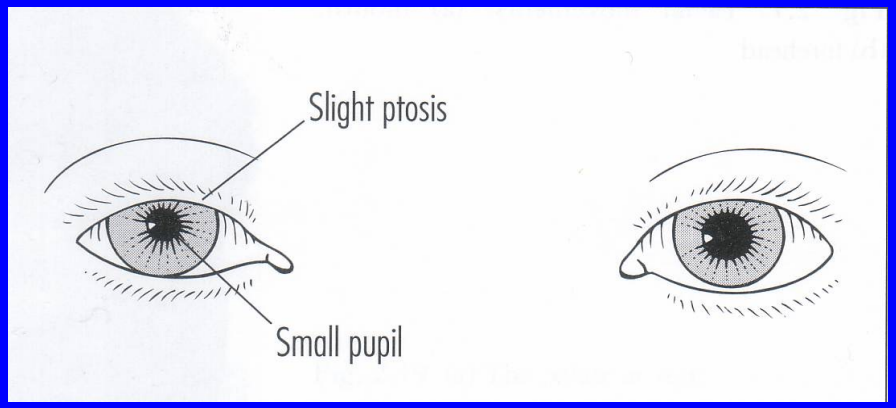
CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Horner (Bernard-Horner) and Stellate Ganglion Syndromes

Interruption of the sympathetic fibers at any point along the internal carotid arteries (postganglionic fibers) or removal of the superior cervical ganglion results in miosis, drooping of the eyelid, apparent enophthalmos, and abolition of sweating over one side of the face. The same syndrome may be caused by interruption of the preganglionic fibers at any point between their origin in the intermediolateral cell column of C8-T2 spinal segments and the superior cervical ganglion or by interruption of the descending, uncrossed hypothalamospinal pathway in the tegmentum of the brainstem or cervical cord. The common causes of the syndrome are tumorous or inflammatory involvement of cervical lymph nodes, surgical and other types of trauma to cervical structures, carotid artery dissection, neoplastic invasion of the proximal part of the brachial plexus, tumor, syringomyelia or traumatic lesions of the first and second thoracic spinal segments, and infarcts or other lesions of the lateral part of the medulla (Wallenberg syndrome).

Right Bernar-Horner Syndrome





partial upper eyelid ptosis + myosis + enophthalmia

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Sympathetic and Parasympathetic Paralysis in Tetraplegia and Paraplegia

Lesions of the C4 or C5 segments of the spinal cord, if complete, will sever all suprasegmental control of the sympathetic and sacral parasympathetic nervous systems. Much the same effects are observed with lesions of the upper thoracic cord (above T6). Lower thoracic lesions leave much of the descending sympathetic outflow intact, only the descending sacral parasympathetic control being interrupted. Traumatic necrosis of the spinal cord is the usual cause of these states, but they may be due as well to infarction, certain forms of myelitis, and tumors. The autonomic changes include hypotension, loss of sweating and piloerection, paralytic ileus, and paralysis of the bladder. After spinal shock dissipates, sympathetic and parasympathetic functions return, since the afferent and efferent autonomic connections within the isolated segments of the spinal cord are intact, although they are no longer under the control of higher centers.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Acute Autonomic Crises (Sympathetic Storm)

Several toxic and pharmacologic agents such as cocaine and phenylpropanolamine are capable of producing abrupt overexcitation of the sympathetic and parasympathetic nervous systems severe hypertension and mydriasis coupled with signs of central nervous system excitation, including seizures. Tricyclic antidepressants in excessive doses are also known to produce autonomic effects, but in this case there is cholinergic blockade, leading to dryness of the mouth, flushing, absent sweating, and mydriasis. During episodes of intense sympathetic discharge, there are intriguing alterations in the ECG, mainly in the ST segments and T waves, and, in extreme cases, evidence of myocardial damage can be observed. A similar hyperadrenergic mechanism has been proposed to explain sudden death from fright, asthma, status epilepticus, and cocaine overdose.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disorders of Sweating

Hyperhidrosis results from overactivity of sudomotor nerve fibers under a variety of conditions. It may occur as an excitatory phase of a peripheral neuropathy (e.g., arsenic, thallium) and be followed by anhidrosis and is one aspect of sympathetic reflex dystrophy. Affections of small nerve fibers, which enhance adrenergic responses, are associated with excessive sweating. The latter is also observed as a localized effect in certain painful mononeuropathies (causalgia) and diffusely in certain painful polyneuropathies ("burning foot" syndrome). A type of nonthermoregulatory hyperhidrosis may occur in spinal paraplegics. Loss of sweating in one part of the body may require a compensatory increase in normal parts for example, the excessive facial and upper truncal sweating that occurs in patients with high transection of the thoracic cord

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Raynaud Syndrome

This disorder, characterized by episodic, painful blanching of the fingers and presumably caused by digital artery spasm, was first described by Raynaud in 1862. It occurs in a number of clinical settings. In the main type, the episodes are brought on by cold or emotional stress and are usually followed by redness on rewarming. In more than half such cases there is an associated systemic disease, usually a connective tissue disease (Porter et al). In these patients, mainly women, the Raynaud syndrome may antedate systemic symptoms by many years. In a second group, predominantly men, the syndrome is induced by local trauma, such as sculling on a cold day, and particularly vibratory injury, incurred by the sustained use of a pneumatic drill, or hammer and chisel (the syndrome is well known to quarry workers). Obstructive arterial disease, as might occur with the thoracic outlet syndrome, vasospasm due to drugs (ergot, cytotoxic agents, beta blockers), previous cold injury, and circulating cryoglobulins or cold agglutinins are less common causes. In 64 of 219 patients studied by Porter and coworkers, the Raynaud syndrome was classified as idiopathic.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

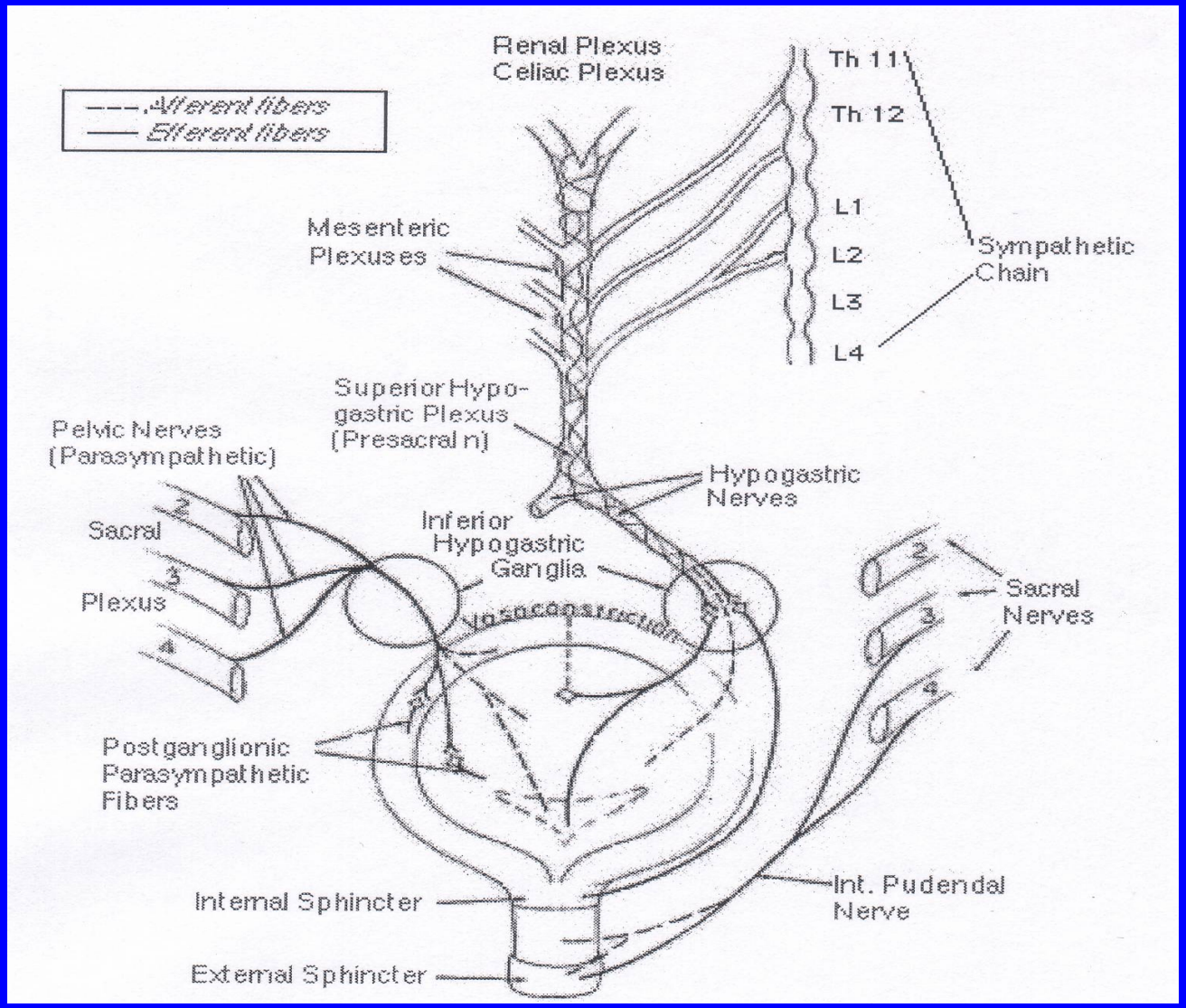
Disturbances of Bladder Function

The familiar functions of the bladder and lower urinary tract the storage and intermittent evacuation of urine are served by three structural components: the large detrusor muscle, which is the bladder itself; a functional internal sphincter muscle; and the striated external sphincter or urogenital diaphragm. The sphincters assure continence during the storage phase; in the male, the internal sphincter also prevents the reflux of semen from the urethra during ejaculation. For micturition to occur, the sphincters must relax, allowing the detrusor to expel urine from the bladder into the urethra. This is accomplished by a complex mechanism involving mainly the parasympathetic nervous system; the sacral peripheral nerves and their somatic sensorimotor fibers; the second, third, and fourth sacral segments of the spinal cord; and the brainstem "micturition centers," with their spinal and suprasegmental connections.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disturbances of Bladder Function



THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disturbances of Sexual Function

Sexual function in the male, which is not infrequently affected in neurologic disease, may be divided into several parts: (1) sexual impulse, drive, or desire, often referred to as libido; (2) penile erection, enabling the act of sexual intercourse (potency); and (3) ejaculation of semen by the prostate through the urethra, whereby impregnation of the female may be accomplished. The arousal of libido in men and women may result from a variety of stimuli, some purely imaginary. Such neocortical influences are transmitted to the limbic system and thence to the hypothalamus and spinal centers. The suprasegmental pathways traverse the lateral funiculi of the spinal cord near the corticospinal tracts to reach sympathetic and parasympathetic segmental centers. Penile erection is effected through sacral parasympathetic motor neurons (S3 and S4) and the nervi erigentes and pudendal nerves.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

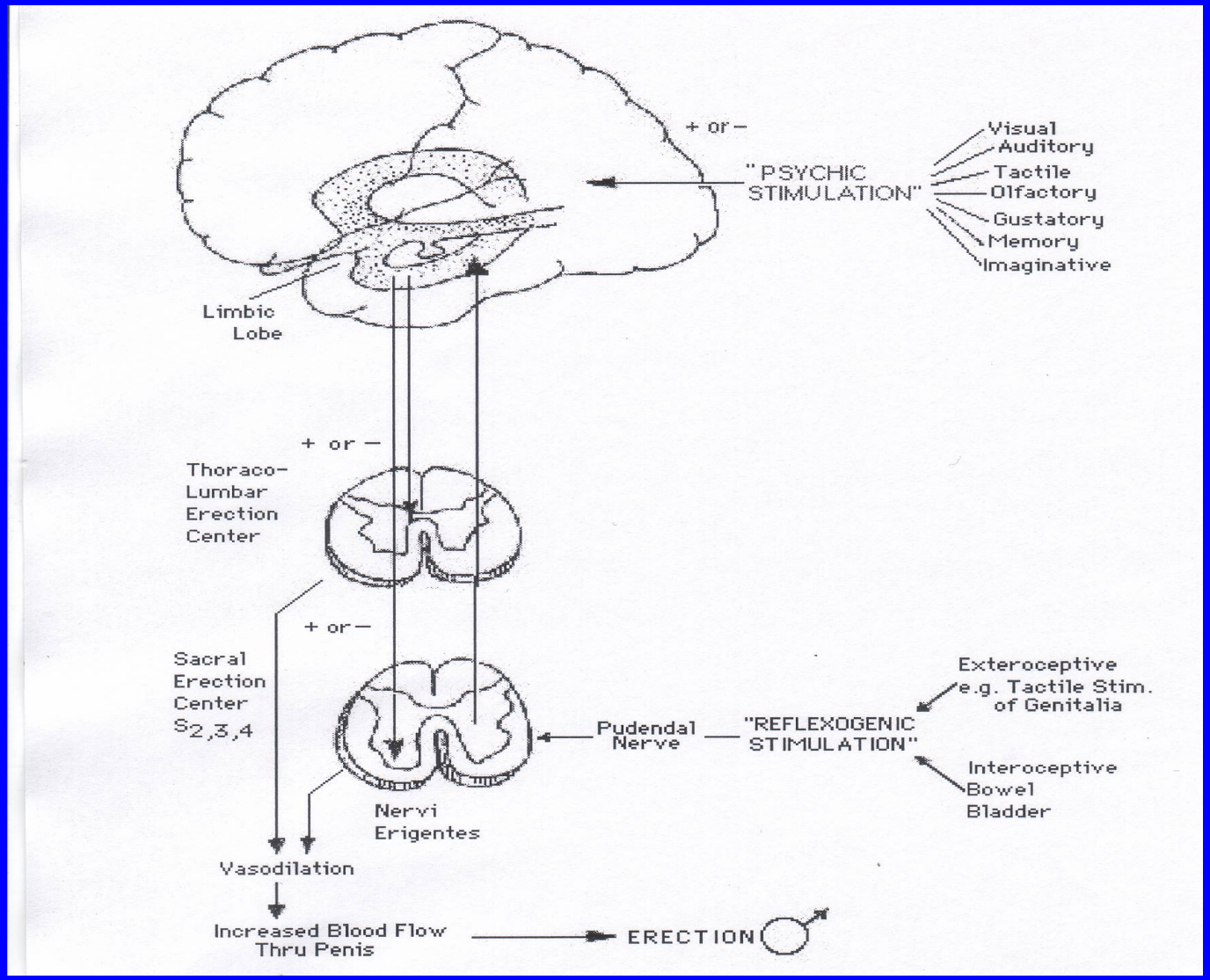
Disturbances of Sexual Function

There is evidence also that a sympathetic outflow from thoracolumbar segments (originating in T12-L1) via the inferior mesenteric and hypogastric plexuses can mediate psychogenic erections in patients with complete sacral cord destruction. Activation from these segmental centers opens vascular channels between arteriolar branches of the pudendal arteries and the vascular spaces of the corpora cavernosa and corpus spongiosum (erectile tissues), resulting in tumescence. Deturgescence occurs when venous channels open widely. Copulation consists of a complex series of rhythmic thrusting movements of pelvic musculature, and ejaculation involves rhythmic contractions of the prostate, compressor (sphincter) urethrae, and bulbocavernosus and ischiocavernosus muscles, which are under the control of both the sympathetic and parasympathetic centers. Afferent segmental influences arise in the glans penis and reach parasympathetic centers at S3 and S4 (reflexogenic erections).

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disturbances of Sexual Function



THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disturbances of Sexual Function

The different aspects of sexual function may be affected separately. Loss of libido may depend upon both psychic and somatic factors. It may be complete, as in old age or in medical and endocrine diseases, or it may occur only in certain circumstances or in relation to a certain situation or individual. In the latter case, which is usually due to psychologic factors, reflex penile erection during REM sleep and even emission of semen may occur, and effective sexual intercourse in other circumstances is possible. Sexual desire can on occasion be altered in the opposite direction, i.e., it may be excessive. This too may be psychologic or psychiatric in origin, as may be seen in manic states, but sometimes it occurs with neurologic disease, such as encephalitis and tumors affecting the diencephalon, septal region, and temporal lobes, in dementias, and as a result of certain medications such as L-dopa.

THE AUTONOMIC NERVOUS SYSTEM

CLINICAL DISORDERS OF THE AUTONOMIC NERVOUS SYSTEM

Disturbances of Sexual Function

On the other hand, sexual desire may be present but penile erection impossible to attain or sustain, a condition called impotence, in which nocturnal erections are usually preserved. The commonest cause of impotence is a depressive state. Prostatectomy is another, the result of damage to the parasympathetic nerves embedded in the capule of the gland. It occurs also in patients who suffer disease of the sacral cord segments and their afferent and efferent connections (e.g., cord tumor, myelitis, tabes, diabetic polyneuropathy), in which case nocturnal erections are absent. The parasympathetic nerves cannot then be activated to cause tumescence of the corpora cavernosa and corpus spongiosum. Diseases of the spinal cord may abolish psychogenic erections, leaving reflexogenic ones intact. In fact, the latter may become overactive, giving rise to sustained painful erections (priapism). This indicates that the segmental mechanism for penile erection is relatively intact.

Mulțumesc pentru atenție!