Chapter 3 - Peripheral nervous system The peripheral nervous system is divided into somatic and autonomic components. The somatic nervous system includes the sensory and motor nerves that innervate the limbs and body wall. Sensory nerve fibers in the peripheral nerves are the peripheral axonal process of neurons in the dorsal root ganglion. The motor axons are the processes of anterior horn cells of the spinal cord. Peripheral nerves have multiple layers of connective tissue surrounding axons, with the endoneurium surrounding individual axons, perineurium binding axons into fascicles and epineurium binding the fascicles into a nerve. There are also blood vessels vasa vasorum and nerves nervi nervorum contained within the nerve. Nerve fibers in peripheral nerves are wavy, such that a length of peripheral nerve can be stretched to half again its length before tension is directly transmitted to nerve fibers. Nerve roots have much less connective tissue, and individual nerve fibers within the roots are straight, leading to some vulnerability. Peripheral nerves receive collateral arterial branches from adjacent arteries. These arteries that contribute to the vasa nervorum anastomose with arterial branches entering the nerve above and below in order to provide an uninterrupted circulation along the course of the nerve. There is usually sufficient collateral circulation to survive damage to one of the feeding arteries. However, this is unpredictable. Individual nerve fibers vary widely in diameter and also may be myelinated or unmyelinated. Myelin in the peripheral nervous system derives from Schwann cells, and the distance between nodes of Ranvier determines the conduction rate. Table 1 shows the functional categories of nerve fibers and the relative speed of conduction. On this table, please note that the function of an axon can be deduced from its diameter and from conduction velocity. Because certain conditions preferentially affect myelin, they would be most likely to affect the functions mediated by the largest, fastest, most heavily myelinated axons see table 1. Sensory neurons are somewhat unique, having an axon that extends to the periphery and another axon that extends into the central nervous system via the dorsal root figure 3. The cell body of this neuron is located in the dorsal root ganglion or one of the sensory ganglia of sensory cranial nerves. Both the peripheral and the central axon attach to the neuron at the same point, and these sensory neurons are called "pseudounipolar" neurons. Before a sensory signal can be relayed to the nervous system it must be transduced into an electrical signal in a nerve fiber. This involves a process of opening ion channels in the membrane in response to mechanical deformation, temperature or, in the case of nociceptive fibers, signals released from damaged tissue. Many receptors become less sensitive with continued stimuli and this is termed adaptation. This adaptation may be rapid or slow, with rapidly adapting receptors being specialized for detecting changing signals. There are several structural types of receptors in the skin. These fall into the category of encapsulated or non-encapsulated receptors. The non-encapsulated endings include free nerve endings, which are simply the peripheral end of the sensory axon. These mostly respond to noxious pain and thermal stimuli. The capsules that surround encapsulated endings change the response characteristics of the nerves. Most encapsulated receptors are for touch, but the Pacinian corpuscles are very rapidly adapting and therefore are specialize to detect vibration. Ultimately, the intensity of the stimulus is encoded by the relative frequency of action potential generation in the sensory axon. In addition to cutaneous receptors, there are muscle receptors that are involved in detecting muscle stretch muscle spindle and muscle tension Golgi tendon organs. Muscle spindles are located in the muscle bellies and consist of intrafusal muscle fibers that are arranged in parallel with the majority of fibers comprising the muscle i. The ends of the intrafusal fibers are contractile and are innervated by gamma motor neurons, while the central portion of the muscle spindle is clear and is wrapped by a sensory nerve ending, the annulospiral ending. This ending is activated by stretch of the muscle spindle or by contraction of the intrafusal fibers see section V. The Golgi tendon organs are located at the myotendinous junction and consist of nerve fibers intertwined with the...
collagen fibers at the myotendinous junctions. They are activated by contraction of the muscle muscle tension. The cutaneous distribution of sensory nerves is shown in figure 4. There is a small area of overlap between sensory distributions of peripheral nerves. It is important to note that there is significant variability in the precise borders of the peripheral distribution of nerves although the general pattern is quite consistent. Nerve roots supply dermatomes figure 5. With few exceptions, there is complete overlap between adjacent dermatomes. This means that the loss of a single nerve root rarely produces significant loss of skin sensitivity. The exception to this rule is found in small patches in the distal extremities, which have been termed "autonomous zones. By their nature the "autonomous zones" represent only a small portion of any dermatome and only a few nerve roots have such autonomous zones. For example, the C5 nerve root may be the sole supply to an area of the lateral arm and proximal part of the lateral forearm. The C6 nerve root may distinctly supply some skin of the thumb and index finger. Injuries to the C7 nerve root may decrease sensation over the middle and sometimes the index finger along with a restricted area on the dorsum of the hand. C8 nerve root lesions can produce similar symptoms over the small digit occasionally extending into the hypothenar area of the hand. In the lower limb, L4 nerve root damage may decrease sensation over the medial part of the leg, while L5 lesions affect sensation over part of the dorsum of the foot and great toe. S1 nerve root lesions typically decrease sensation on the lateral side of the foot. In addition to sensory problems, peripheral nerve injury can affect strength. The principal innervation for the most important muscles is depicted in table 2. Damage to peripheral nerves often produces a very recognizable pattern of severe weakness and with time atrophy. Damage to single nerve roots usually does not produce complete weakness of muscles since there are no muscles supplied by a single nerve root. Nonetheless, there is often detectible weakness. Examples in the upper extremity include weakness of shoulder abductors and external rotators with C5 nerve root lesions, weakness of elbow flexors with C6 nerve root lesions, possible weakness of wrist and finger extension with C7 nerve root lesions and some weakness of intrinsic hand muscles with C8 and T1 lesions. In the lower extremity, there may be some weakness of knee extension with L3 or L4 lesions, some difficulty with great toe and, to a lesser extent, ankle extension with L5 lesions and weakness of great toe plantar flexion with S1 nerve root damage. Motor nerve fibers end in myoneural junctions. These consist of a single motor axon terminal on a skeletal muscle fiber. The myoneural junction includes a complex infolding of the muscle membrane, the ridges of which contain nicotinic acetylcholine receptors. There is also a matrix in the synaptic cleft containing acetylcholinesterase, involved in termination of action of the neurotransmitter. One motor neuron has connections with many muscle fibers through collateral branches of the axon. This is called the "motor unit" and can vary from a handful of muscle fibers per motor neuron in muscles of very fine control such as eye muscles up to several thousands as in the gluteal muscles. Autonomic nervous system The autonomic nervous system consists of two main divisions, the sympathetic and the parasympathetic nervous systems. The sympathetics are primarily involved in responses that would be associated with fighting or fleeing, such as increasing heart rate and blood pressure as well as constricting blood vessels in the skin and dilating them in muscles. The parasympathetic nervous system is involved in energy conservation functions and increases gastrointestinal motility and secretion. It also increases bladder contractility. There are some areas in which blood vessels are under competing sympathetic and parasympathetic control, such as in the nose or erectile tissues. There some areas where there is a competitive balance between sympathetics and parasympathetics, such as the effects on heart rate or the pupil. For some functions sympathetics and parasympathetics cooperate; an example being parasympathetic nerves, which are necessary for erection and sympathetics for ejaculation. Both the sympathetic and parasympathetic portions of the autonomic nervous system have a two neuron pathway from the central nervous system to the peripheral organ. Therefore, there is a ganglion interposed in each of these pathways, with the exception of the sympathetic pathway to the adrenal medulla. The adrenal medulla basically functions as a sympathetic ganglion. The two nerve fibers in the pathway are termed preganglionic and postganglionic. At the level of the autonomic ganglia the neurotransmitter is typically acetylcholine. Postganglionic parasympathetic neurons also release acetylcholine
while norepinephrine is the postganglionic transmitter for most sympathetic nerve fibers. The exception is the use of acetylcholine in sympathetic transmission to the sweat glands and erector pili muscles as well as to some blood vessels in muscle. Sympathetic preganglionic neurons are located between T1 and L2 in the lateral horn of the spinal cord. Therefore, sympathetics have been termed the "thoracolumbar outflow. This chain of connected ganglia follows the sides of the vertebrae all the way from the head to the coccyx. These axons may synapse with postganglionic neurons in these paravertebral ganglia. Alternatively, preganglionic fibers can pass directly through the gangliated chain to reach prevertebral ganglia along the aorta via splanchnic nerves. Additionally, these preganglionics can pass rostrally or caudally through the gangliated chain to reach the head or the lower lumbosacral regions. The sympathetic pathway to the head is shown in figure 6. Sympathetic fibers can go to viscera by one of two pathways. Some postganglionic can leave the gangliated chain and follow blood vessels to the organs. Alternatively, preganglionic fibers may pass directly through the gangliated chain to enter the abdomen as splanchnic nerves. These synapse in ganglia located along the aorta the celiac, renal, superior or inferior mesenteric ganglia with postganglionic. Again, postganglionics follow the blood vessels. Sympathetic postganglionics from the gangliated chain can go back to the spinal nerves via gray rami communicans to be distributed to somatic tissues of the limbs and body walls. For example, the somatic response to sympathetic activation will result in sweating, constriction of blood vessels in the skin, dilation of vessels in muscle and in piloerection. This can happen anywhere along the course of the nerve pathway including the upper thoracic spine and nerve roots, the apex of the lung, the neck or the carotid plexus of postganglionics. Therefore, they have been termed the "craniosacral outflow. Parasympathetics in cranial nerve VII synapse in the pterygopatine ganglion lacrimation or the submandibular ganglion salivation while those in cranial nerve IX synapse in the otic ganglion salivation from parotid gland. The vagus nerve follows a long course to supply the thoracic and abdominal organs up to the level of the distal transverse colon, synapsing in ganglia very close to or within the organ walls. The pelvic parasympathetics, which appear as "pelvic splanchnic nerves" activate bladder contraction and also supply lower abdominal and pelvic organs.
Figure legends Chapter 3: The nervous system The nervous system comprises the central nervous system, consisting of the brain and spinal cord, and the peripheral nervous system, consisting of the cranial, spinal, and peripheral nerves, together with their motor and sensory endings. Central nervous system The central nervous system is composed of millions of nerve and glial cells, together with blood vessels and a little connective tissue. The nerve cells, or neurons, are characterized by many processes and are specialized for reception and transmission of signals. The glial cells, termed neuroglia, are characterized by short processes that have special relationships to neurons, blood vessels, and connective tissue. Brain The brain is the enlarged, head end of the central nervous system; it occupies the cranium, or brain case. The term cerebrum L. Encephalon, of Greek origin, is found in such terms as encephalitis, which means inflammation of the brain. The brain presents three main divisions: The forebrain in turn has two subdivisions, telencephalon endbrain and diencephalon interbrain. The hindbrain likewise has two subdivisions, the metencephalon afterbrain and the myelencephalon marrowbrain. The bulk of the brain is formed by two cerebral hemispheres, which are derived from the telencephalon. The hemispheres are distinguished by convolutions, or gyri, which are separated by sulci. The diencephalon lies between the hemispheres. It forms the upper part of the brain stem, an unpaired stalk that descends from the base of the brain. The brain stem is formed by the diencephalon, midbrain, pons, and myelencephalon, or medulla oblongata. The last is continuous with the spinal cord at the foramen magnum. The cerebellum is a fissured mass of gray matter that occupies the posterior cranial fossa and is attached to the brain stem by three pairs of peduncles. Twelve pairs of cranial nerves issue from the base of the brain and brain stem. The cerebral cortex, which is the most superficial part of the hemispheres and is only a few millimeters in thickness, is composed of gray matter, in contrast to the interior of the hemispheres, which is composed partly of white matter. Gray matter consists largely of the bodies of nerve and glial cells, whereas white matter consists largely of the processes or fibers of nerve and glial cells. The interior of the cerebral hemispheres, including the diencephalon, contains not only white matter but also large masses of gray matter known collectively as basal ganglia. This term is a misnomer since the term "ganglion" should be reserved for collections of nerve cell bodies outside the central nervous system and nuclei should be used for collections of neurons inside. Therefore, it would be more appropriate to call these "basal nuclei" however, that term is reserved for another structure. The cerebellar cortex, like the cerebral, is composed of a thin rind of gray matter. The interior of the cerebellum is composed mainly of white matter, but also contains nuclei of gray matter. The brain stem, by contrast, contains nuclei and diffuse masses of gray matter in its interior. The interior of the brain also contains cavities termed ventricles, which are filled with cerebrospinal fluid. Functions The highest mental and behavioral activities characteristic of humans are mediated by the cerebral hemispheres, in particular by the cerebral cortex. Important aspects of these functions are learning and language. In addition, there are association mechanisms for the integration of motor and sensory functions. Some areas of the cerebral hemispheres control muscular activity, and their nerve cells send processes to the brain stem and spinal cord, where they are connected with motor neurons, the processes of which leave by way of cranial nerves or ventral roots in the spinal cord. Other areas are sensory and receive impulses that have reached the spinal cord by way of peripheral nerves and dorsal roots, and have ascended in the spinal cord and brain stem by pathways that consist of a succession of nerve cells and their processes. Fibers that ascend and descend in the brain and spinal cord often segregate into bundles having similar courses and functions, known as "tracts"are generally grouped into tracts. The tracts are usually named according to their origin and destination, e. The brain stem contains, in addition to tracts that descend and ascend through it, collections of cells that 1 comprise major integrating centers for motor and sensory functions, 2 form the
nuclei of most cranial nerves all of the cranial nerves except the first are attached to the brain stem, 3 form centers concerned with the regulation of a variety of visceral, endocrinological, behavioral, and other activities, 4 are functionally associated with most of the special senses, 5 control muscular activity in the head and part of the neck, 6 supply pharyngeal arch structures, and 7 are connected with the cerebellum. The cerebellum is concerned with the automatic regulation of movement and posture, and the learning of new motor patterns. It functions closely with the cerebral cortex and the brain stem. Spinal cord The spinal cord is a long, cylindrical mass of nervous tissue, oval or rounded in transverse section. It occupies the upper two-thirds of the vertebral canal. In contrast to the cerebral hemispheres, gray matter is found in the interior, surrounded by white matter. The neurons of the spinal cord include 1 somatic motor cells, the axons of which leave by way of ventral roots and supply skeletal muscles; 2 autonomic motor cells, the axons of which leave by way of ventral roots and go to autonomic ganglia; and 3 transmission neurons that give rise to ascending projections to the brain and to connections with other spinal cord levels; and 4 interneurons, which connect with other neurons at the spinal level and are concerned with sensory and reflex mechanisms. The white matter contains ascending and descending tracts. Some ascend to or descend from the brain, whereas others connect cells at various levels of the cord. Attached to the spinal cord on each side is a series of spinal roots, termed dorsal and ventral according to their position. Generally there are 31 pairs, which comprise 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. Corresponding dorsal and ventral roots join to form a spinal nerve. Each spinal nerve divides into a dorsal and a ventral ramus, and these are distributed to various parts of the body. The spinal cord carries out sensory, integrative, and motor functions, which can be categorized as reflex, reciprocal activity as one activity starts, another stops, monitoring and modulation of sensory and motor mechanisms, and transmission of impulses to the brain. Meninges and cerebrospinal fluid The brain and spinal cord are surrounded and protected by layers of non-nervous tissue, collectively termed meninges. These layers, from without inward, are the dura mater, arachnoid, and pia mater, and are described in more detail elsewhere. The space between the arachnoid and the pia mater, the subarachnoid space, contains cerebrospinal fluid CSF. The ventricles of the brain contain vascular choroid plexuses, from which CSF is formed. This fluid circulates through the ventricles, enters the subarachnoid space, and eventually filters into the venous system. CSF protects the brain which basically floats. It serves to minimize damage from blows to the head and neck. Blood supply The brain is supplied by the cerebral branches of the vertebral and internal carotid arteries, the meninges mainly by the middle meningeal branch of the maxillary artery. The spinal cord and spinal roots are supplied by the vertebral arteries and by segmental arteries. Peripheral nerves are supplied by a number of small branches along the course of the nerves. Peripheral nervous system A nerve is a collection of nerve fibers that is visible to the naked eye. The constituent fibers are bound together by connective tissue. Each fiber is microscopic in size and is surrounded by a sheath formed by a neurilemmal cell comparable to the glial cells of the central nervous system. Hundreds or thousands of fibers are present in each nerve. Thus, according to the number of constituent fibers, a nerve may be barely visible, or it may be quite thick. A nerve as a whole is surrounded by a connective tissue sheath, the epineurium. Connective tissue fibers run inward from the sheath and enclose bundles of nerve fibers. Such bundles are termed fasciculi funiculi; the connective tissue that encloses them is called perineurium. Very small nerves may consist of only one fasciculus derived from the parent nerve. Finally, each nerve fiber and its neurilemmal sheath are enclosed by a connective tissue sheath termed endoneurium. Peripheral nerve fibers may be classified according to the structures they supply, that is, according to function. A fiber that stimulates or activates skeletal muscle is termed a motor efferent fiber. A fiber that carries impulses from a sensory ending is termed a sensory afferent fiber. Fibers that activate glands and smooth muscle are also motor fibers, and various kinds of sensory fibers arise from endings in viscera. Consequently, a more detailed classification of functional components is sometimes required. Spinal nerves The spinal roots, which are anchored to the spinal cord, consist of a dorsal root, attached to the dorsal aspect of the spinal cord, and a ventral root, attached to the ventral aspect of the cord. Each dorsal root which contains sensory fibers from skin, subcutaneous and deep tissues, and often from
viscera also is formed by neuronal processes that carry afferent impulses into the spinal cord and which arise from neurons that are collected together to form an enlargement termed a spinal dorsal root ganglion fig. The peripheral processes from the dorsal root ganglion neurons arise directly within the organ or structure from which they are conveying sensation. Each of the ventral roots which contain motor fibers to skeletal muscle, and of which many contain preganglionic autonomic fibers is formed by processes of neurons in the gray matter of the spinal cord. While the projections from the motor neurons to skeletal muscle go directly to their termination in the muscle, the autonomic motor axons synapse on neurons in a ganglion hence the term preganglionic. The neurons in the ganglion postganglionic neurons have axons that reach their target on glands or smooth muscles. Basically, dorsal roots are afferent, ventral roots efferent. The corresponding dorsal and ventral roots join to form a spinal nerve. Each spinal nerve then divides into a dorsal and a ventral primary ramus. Distribution of spinal and peripheral nerves The dorsal primary rami or just dorsal rami of spinal nerves supply the skin and muscles of the back. The ventral primary rami ventral rami supply the limbs and the rest of the trunk. The ventral rami that supply the thoracic and abdominal wall remain relatively separate throughout their course. In the cervical and lumbosacral regions, however, the ventral rami intermingle to form plexuses, from which the major peripheral nerves emerge. When the ventral ramus of a spinal nerve enters a plexus and joins other such rami, its component funiculi or bundles ultimately enter several of the nerves emerging from the plexus. Thus, as a general principle, each spinal nerve entering a plexus contributes to several peripheral nerves, and each peripheral nerve contains fibers derived from several spinal nerves. This arrangement leads to two fundamental and important types of distribution fig. Each spinal nerve has a segmental, or dermatomal, distribution. A dermatome is the area of skin supplied by the sensory fibers of a single dorsal root through the dorsal and ventral rami of its spinal nerve. Dermatomes based largely on Foerster are shown in this figure. The mixture of nerve fibers in plexuses is such that it is difficult if not impossible to trace their course by dissection; hence, dermatomal distribution has been determined by physiological experimentation and by studies of disorders of spinal nerves. Methods have included stimulation of spinal roots, study of residual sensation when a root is left intact after section of the roots above and below it, study of the diminution of sensation after section of a single root, and study of the distribution of the vesicles that follow inflammation of roots and spinal ganglia in herpes zoster shingles. Such studies have yielded complex maps, chiefly because of variation, overlap, and differences in method. Variation results from intersegmental rootlet anastomoses adjacent to the cervical and lumbosacral spinal cord and from individual differences in plexus formation and peripheral nerve distribution. Overlap is such that section of a single root does not produce complete anesthesia in the area supplied by that root: By contrast, when a peripheral nerve is cut, the result is a central area of total loss of sensation surrounded by an area of diminished sensation.
The parasympathetic nervous system has been said to promote a "rest and digest" response, promotes calming of the nerves return to regular function, and enhancing digestion. Functions of nerves within the parasympathetic nervous system include: Constricting the bronchiolar diameter when the need for oxygen has diminished. Dedicated cardiac branches of the vagus and thoracic spinal accessory nerves impart parasympathetic control of the heart myocardium. Constriction of the pupil and contraction of the ciliary muscles, facilitating accommodation and allowing for closer vision. Stimulating salivary gland secretion, and accelerates peristalsis, mediating digestion of food and, indirectly, the absorption of nutrients. Sexual nerves of the peripheral nervous system are involved in the erection of genital tissues via the pelvic splanchnic nerves 2â€”4. They are also responsible for stimulating sexual arousal. Enteric nervous system[ edit ] The enteric nervous system is the intrinsic nervous system of the gastrointestinal system. It has been described as "the Second Brain of the Human Body". Sensing chemical and mechanical changes in the gut. Regulating secretions in the gut Controlling peristalsis and some other movements Main articles: Table of neurotransmitter actions in the ANS and Non-noradrenergic, non-cholinergic transmitter A flow diagram showing the process of stimulation of adrenal medulla that makes it release adrenaline, that further acts on adrenoreceptors, indirectly mediating or mimicking sympathetic activity. At the effector organs, sympathetic ganglionic neurons release noradrenaline norepinephrine, along with other cotransmitters such as ATP, to act on adrenergic receptors, with the exception of the sweat glands and the adrenal medulla: Acetylcholine is the preganglionic neurotransmitter for both divisions of the ANS, as well as the postganglionic neurotransmitter of parasympathetic neurons. Nerves that release acetylcholine are said to be cholinergic. In the parasympathetic system, ganglionic neurons use acetylcholine as a neurotransmitter to stimulate muscarinic receptors. At the adrenal medulla, there is no postsynaptic neuron. Instead the presynaptic neuron releases acetylcholine to act on nicotinic receptors. Stimulation of the adrenal medulla releases adrenaline epinephrine into the bloodstream, which acts on adrenoceptors, thereby indirectly mediating or mimicking sympathetic activity. Caffeine effects[ edit ] Caffeine is a bio-active ingredient found in commonly consumed beverages such as coffee, tea, and sodas. Short-term physiological effects of caffeine include increased blood pressure and sympathetic nerve outflow. Habitual consumption of caffeine may inhibit physiological short-term effects. Consumption of caffeinated espresso increases parasympathetic activity in habitual caffeine consumers; however, decaffeinated espresso inhibits parasympathetic activity in habitual caffeine consumers. It is possible that other bio-active ingredients in decaffeinated espresso may also contribute to the inhibition of parasympathetic activity in habitual caffeine consumers. In one study, caffeine provoked a greater maximum heart rate while a strenuous task was being performed compared to a placebo. Furthermore, this study found that recovery after intense exercise was slower when caffeine was consumed prior to exercise. The caffeine-stimulated increase in nerve activity is likely to evoke other physiological effects as the body attempts to maintain homeostasis. It is important to note that the data supporting increased parasympathetic activity in the supine position was derived from an experiment involving participants between the ages of 25 and 30 who were considered healthy and sedentary. Caffeine may influence autonomic activity differently for individuals who are more active or elderly.
Chapter 4: The nervous system

ANS is the GENERAL VISCERAL MOTOR DIVISIONS of the PNS-system of motor neurons that innervates smooth muscles, cardiac muscle, and glands-regulates body temp, coordinates cardiovascular, respiratory, digestive, excretory, and reproductive functions.

Edited and Revised by Lindsay M. The Peripheral Nervous System The arrangement of these nerves is much more regular than that of the cranial nerves. All of the spinal nerves are combined sensory and motor axons that separate into two nerve roots. The sensory axons enter the spinal cord as the dorsal nerve root. The motor fibers, both somatic and autonomic, emerge as the ventral nerve root. The dorsal root ganglion for each nerve is an enlargement of the spinal nerve. There are 31 spinal nerves, named for the level of the spinal cord at which each one emerges. There are eight pairs of cervical nerves designated C1 to C8, twelve thoracic nerves designated T1 to T12, five pairs of lumbar nerves designated L1 to L5, five pairs of sacral nerves designated S1 to S5, and one pair of coccygeal nerves. The nerves are numbered from the superior to inferior positions, and each emerges from the vertebral column through the intervertebral foramen at its level. The first nerve, C1, emerges between the first cervical vertebra and the occipital bone. The second nerve, C2, emerges between the first and second cervical vertebrae. The same occurs for C3 to C7, but C8 emerges between the seventh cervical vertebra and the first thoracic vertebra. For the thoracic and lumbar nerves, each one emerges between the vertebra that has the same designation and the next vertebra in the column. The sacral nerves emerge from the sacral foramina along the length of that unique vertebra. Spinal nerves extend outward from the vertebral column to enervate the periphery. The nerves in the periphery are not straight continuations of the spinal nerves, but rather the reorganization of the axons in those nerves to follow different courses. Axons from different spinal nerves will come together into a systemic nerve. This occurs at four places along the length of the vertebral column, each identified as a nerve plexus, whereas the other spinal nerves directly correspond to nerves at their respective levels. In this instance, the word plexus is used to describe networks of nerve fibers with no associated cell bodies. Of the four nerve plexuses, two are found at the cervical level, one at the lumbar level, and one at the sacral level Figure The cervical plexus is composed of axons from spinal nerves C1 through C5 and branches into nerves in the posterior neck and head, as well as the phrenic nerve, which connects to the diaphragm at the base of the thoracic cavity. The other plexus from the cervical level is the brachial plexus. Spinal nerves C4 through T1 reorganize through this plexus to give rise to the nerves of the arms, as the name brachial suggests. A large nerve from this plexus is the radial nerve from which the axillary nerve branches to go to the armpit region. The radial nerve continues through the arm and is paralleled by the ulnar nerve and the median nerve. The lumbar plexus arises from all the lumbar spinal nerves and gives rise to nerves enervating the pelvic region and the anterior leg. The femoral nerve is one of the major nerves from this plexus, which gives rise to the saphenous nerve as a branch that extends through the anterior lower leg. The sacral plexus comes from the lower lumbar nerves L4 and L5 and the sacral nerves S1 to S4. The most significant systemic nerve to come from this plexus is the sciatic nerve, which is a combination of the tibial nerve and the fibular nerve. The sciatic nerve extends across the hip joint and is most commonly associated with the condition sciatica, which is the result of compression or irritation of the nerve or any of the spinal nerves giving rise to it. These plexuses are described as arising from spinal nerves and giving rise to certain systemic nerves, but they contain fibers that serve sensory functions or fibers that serve motor functions. This means that some fibers extend from cutaneous or other peripheral sensory surfaces and send action potentials into the CNS. Those are axons of sensory neurons in the dorsal root ganglia that enter the spinal cord through the dorsal nerve root. Other fibers are the axons of motor neurons of the anterior horn of the spinal cord, which emerge in the ventral nerve root and send action potentials to cause skeletal muscles to contract in their target regions. For example, the radial nerve contains fibers of cutaneous sensation in the arm, as well as motor fibers that move muscles in the arm. Spinal nerves of the thoracic region, T2 through T11, are
not part of the plexuses but rather emerge and give rise to the intercostal nerves found between the ribs, which articulate with the vertebrae surrounding the spinal nerve. There are four main nerve plexuses in the human body. The cervical plexus supplies nerves to the posterior head and neck, as well as to the diaphragm. The brachial plexus supplies nerves to the arm. The lumbar plexus supplies nerves to the anterior leg. The sacral plexus supplies nerves to the posterior leg. Cranial Nerves The nerves attached to the brain are the cranial nerves, which are primarily responsible for the sensory and motor functions of the head and neck one of these nerves targets organs in the thoracic and abdominal cavities as part of the parasympathetic nervous system. They can be classified as sensory nerves, motor nerves, or a combination of both, meaning that the axons in these nerves originate out of sensory ganglia external to the cranium or motor nuclei within the brain stem. Sensory axons enter the brain to synapse in a nucleus. Motor axons connect to skeletal muscles of the head or neck. Three of the nerves are solely composed of sensory fibers; five are strictly motor; and the remaining four are mixed nerves. Learning the cranial nerves is a tradition in anatomy courses, and students have always used mnemonic devices to remember the nerve names. The names of the nerves have changed over the years to reflect current usage and more accurate naming. An exercise to help learn this sort of information is to generate a mnemonic using words that have personal significance. The names of the cranial nerves are listed in Table 3 along with a brief description of their function, their source sensory ganglion or motor nucleus, and their target sensory nucleus or skeletal muscle. They are listed here with a brief explanation of each nerve.

Figure The olfactory nerve and optic nerve are responsible for the sense of smell and vision, respectively. The oculomotor nerve is responsible for eye movements by controlling four of the extraocular muscles. It is also responsible for lifting the upper eyelid when the eyes point up, and for pupillary constriction. The trochlear nerve and the abducens nerve are both responsible for eye movement, but do so by controlling different extraocular muscles. The trigeminal nerve is responsible for cutaneous sensations of the face and controlling the muscles of mastication. The facial nerve is responsible for the muscles involved in facial expressions, as well as part of the sense of taste and the production of saliva. The vestibulocochlear nerve is responsible for the senses of hearing and balance. The glossopharyngeal nerve is responsible for controlling muscles in the oral cavity and upper throat, as well as part of the sense of taste and the production of saliva. The vagus nerve is responsible for contributing to homeostatic control of the organs of the thoracic and upper abdominal cavities. The spinal accessory nerve is responsible for controlling the muscles of the neck, along with cervical spinal nerves. The hypoglossal nerve is responsible for controlling the muscles of the lower throat and tongue. The anatomical arrangement of the roots of the cranial nerves observed from an inferior view of the brain. Three of the cranial nerves also contain autonomic fibers, and a fourth is almost purely a component of the autonomic system. The oculomotor, facial, and glossopharyngeal nerves contain fibers that contact autonomic ganglia. The oculomotor fibers initiate pupillary constriction, whereas the facial and glossopharyngeal fibers both initiate salivation. The vagus nerve primarily targets autonomic ganglia in the thoracic and upper abdominal cavities. External Website Visit this site to read about a man who wakes with a headache and a loss of vision. His regular doctor sent him to an ophthalmologist to address the vision loss. The ophthalmologist recognizes a greater problem and immediately sends him to the emergency room. Once there, the patient undergoes a large battery of tests, but a definite cause cannot be found. A specialist recognizes the problem as meningitis, but the question is what caused it originally. How can that be cured? The loss of vision comes from swelling around the optic nerve, which probably presented as a bulge on the inside of the eye. Why is swelling related to meningitis going to push on the optic nerve? Another important aspect of the cranial nerves that lends itself to a mnemonic is the functional role each nerve plays. The nerves fall into one of three basic groups. They are sensory, motor, or both see Table 3. The first, second, and eighth nerves are purely sensory: The three eye-movement nerves are all motor: The remainder of the nerves contain both sensory and motor fibers. The nerves that convey both are often related to each other. The trigeminal and facial nerves both concern the face; one concerns the sensations and the other concerns the muscle movements. The facial and glossopharyngeal nerves are both responsible for conveying gustatory, or taste, sensations as well as...
controlling salivary glands. The vagus nerve is involved in visceral responses to taste, namely the gag reflex. This is not an exhaustive list of what these combination nerves do, but there is a thread of relation between them. Cranial Nerves Table 3.
The autonomic nervous system regulates organ systems through circuits that resemble the reflexes described in the somatic nervous system. The main difference between the somatic and autonomic systems is in what target tissues are effectors. Somatic responses are solely based on skeletal muscle contraction. The autonomic system, however, targets cardiac and smooth muscle, as well as glandular tissue. Whereas the basic circuit is a reflex arc, there are differences in the structure of those reflexes for the somatic and autonomic systems. The structure of reflexes One difference between a somatic reflex, such as the withdrawal reflex, and a visceral reflex, which is an autonomic reflex, is in the efferent branch. The output of a somatic reflex is the lower motor neuron in the ventral horn of the spinal cord that projects directly to a skeletal muscle to cause its contraction. The output of a visceral reflex is a two-step pathway starting with the preganglionic fiber emerging from a lateral horn neuron in the spinal cord, or a cranial nucleus neuron in the brain stem, to a ganglion—followed by the postganglionic fiber projecting to a target effector. The other part of a reflex, the afferent branch, is often the same between the two systems. Sensory neurons receiving input from the periphery with cell bodies in the sensory ganglia, either of a cranial nerve or a dorsal root ganglion adjacent to the spinal cord project into the CNS to initiate the reflex. The afferent inputs to somatic and visceral reflexes are essentially the same, whereas the efferent branches are different. Somatic reflexes, for instance, involve a direct connection from the ventral horn of the spinal cord to the skeletal muscle to cause its contraction. Visceral reflexes involve a projection from the central neuron to a ganglion, followed by a second projection from the ganglion to the target effector. Afferent Branch The afferent branch of a reflex arc does differ between somatic and visceral reflexes in some instances. Many of the inputs to visceral reflexes are from special or somatic senses, but particular senses are associated with the viscera that are not part of the conscious perception of the environment through the somatic nervous system. For example, there is a specific type of mechanoreceptor, called a baroreceptor, in the walls of the aorta and carotid sinuses that senses the stretch of those organs when blood volume or pressure increases. You do not have a conscious perception of having high blood pressure, but that is an important afferent branch of the cardiovascular and, particularly, vasomotor reflexes. The sensory neuron is essentially the same as any other general sensory neuron. The baroreceptor apparatus is part of the ending of a unipolar neuron that has a cell body in a sensory ganglion. The baroreceptors from the carotid arteries have axons in the glossopharyngeal nerve, and those from the aorta have axons in the vagus nerve. Though visceral senses are not primarily a part of conscious perception, those sensations sometimes make it to conscious awareness. If a visceral sense is strong enough, it will be perceived. The sensory homunculus the representation of the body in the primary somatosensory cortex only has a small region allotted for the perception of internal stimuli. If you swallow a large bolus of food, for instance, you will probably feel the lump of that food as it pushes through your esophagus, or even if your stomach is distended after a large meal. If you inhale especially cold air, you can feel it as it enters your larynx and trachea. These sensations are not the same as feeling high blood pressure or blood sugar levels. When particularly strong visceral sensations rise to the level of conscious perception, the sensations are often felt in unexpected places. For example, strong visceral sensations of the heart will be felt as pain in the left shoulder and left arm. This irregular pattern of projection of conscious perception of visceral sensations is called referred pain. Depending on the organ system affected, the referred pain will project to different areas of the body. The location...
of referred pain is not random, but a definitive explanation of the mechanism has not been established. The most broadly accepted theory for this phenomenon is that the visceral sensory fibers enter into the same level of the spinal cord as the somatosensory fibers of the referred pain location. By this explanation, the visceral sensory fibers from the mediastinal region, where the heart is located, would enter the spinal cord at the same level as the spinal nerves from the shoulder and arm, so the brain misinterprets the sensations from the mediastinal region as being from the axillary and brachial regions. Projections from the medial and inferior divisions of the cervical ganglia do enter the spinal cord at the middle to lower cervical levels, which is where the somatosensory fibers enter. Conscious perception of visceral sensations map to specific regions of the body, as shown in this chart. Some sensations are felt locally, whereas others are perceived as affecting areas that are quite distant from the involved organ. Disorders of the Nervous System: The spleen is in the upper-left abdominopelvic quadrant, but the pain is more in the shoulder and neck. How can this be? The sympathetic fibers connected to the spleen are from the celiac ganglion, which would be from the mid-thoracic to lower thoracic region whereas parasympathetic fibers are found in the vagus nerve, which connects in the medulla of the brain stem. However, the neck and shoulder would connect to the spinal cord at the mid-cervical level of the spinal cord. These connections do not fit with the expected correspondence of visceral and somatosensory fibers entering at the same level of the spinal cord. The incorrect assumption would be that the visceral sensations are coming from the spleen directly. In fact, the visceral fibers are coming from the diaphragm. The nerve connecting to the diaphragm takes a special route. The phrenic nerve is connected to the spinal cord at cervical levels 3 to 5. The motor fibers that make up this nerve are responsible for the muscle contractions that drive ventilation. These fibers have left the spinal cord to enter the phrenic nerve, meaning that spinal cord damage below the mid-cervical level is not fatal by making ventilation impossible. Therefore, the visceral fibers from the diaphragm enter the spinal cord at the same level as the somatosensory fibers from the neck and shoulder. When the spleen ruptures, blood spills into this region. The accumulating hemorrhage then puts pressure on the diaphragm. The visceral sensation is actually in the diaphragm, so the referred pain is in a region of the body that corresponds to the diaphragm, not the spleen. Efferent Branch The efferent branch of the visceral reflex arc begins with the projection from the central neuron along the preganglionic fiber. This fiber then makes a synapse on the ganglionic neuron that projects to the target effector. The effector organs that are the targets of the autonomic system range from the iris and ciliary body of the eye to the urinary bladder and reproductive organs. The thoracolumbar output, through the various sympathetic ganglia, reaches all of these organs. The cranial component of the parasympathetic system projects from the eye to part of the intestines. The sacral component picks up with the majority of the large intestine and the pelvic organs of the urinary and reproductive systems. Short and Long Reflexes Somatic reflexes involve sensory neurons that connect sensory receptors to the CNS and motor neurons that project back out to the skeletal muscles. Visceral reflexes that involve the thoracolumbar or craniosacral systems share similar connections. However, there are reflexes that do not need to involve any CNS components. A long reflex has afferent branches that enter the spinal cord or brain and involve the efferent branches, as previously explained. A short reflex is completely peripheral and only involves the local integration of sensory input with motor output Figure Sensory input can stimulate either a short or a long reflex. A sensory neuron can project to the CNS or to an autonomic ganglion. The short reflex involves the direct stimulation of a postganglionic fiber by the sensory neuron, whereas the long reflex involves integration in the spinal cord or brain. The difference between short and long reflexes is in the involvement of the CNS. Somatic reflexes always involve the CNS, even in a monosynaptic reflex in which the sensory neuron directly activates the motor neuron. That synapse is in the spinal cord or brain stem, so it has to involve the CNS. However, in the autonomic system there is the possibility that the CNS is not involved. If a sensory neuron projects directly to the ganglionic neuron and causes it to activate the effector target, then the CNS is not involved. A division of the nervous system that is related to the autonomic nervous system is the enteric nervous system. The word enteric refers to the digestive organs, so this represents the nervous tissue that is part of the digestive system.
There are a few myenteric plexuses in which the nervous tissue in the wall of the digestive tract organs can directly influence digestive function. If stretch receptors in the stomach are activated by the filling and distension of the stomach, a short reflex will directly activate the smooth muscle fibers of the stomach wall to increase motility to digest the excessive food in the stomach. No CNS involvement is needed because the stretch receptor is directly activating a neuron in the wall of the stomach that causes the smooth muscle to contract. That neuron, connected to the smooth muscle, is a postganglionic parasympathetic neuron that can be controlled by a fiber found in the vagus nerve. External Website Read this article to learn about a teenager who experiences a series of spells that suggest a stroke. He undergoes endless tests and seeks input from multiple doctors. In the end, one expert, one question, and a simple blood pressure cuff answers the question. Why would the heart have to beat faster when the teenager changes his body position from lying down to sitting, and then to standing? Balance in Competing Autonomic Reflex Arcs The autonomic nervous system is important for homeostasis because its two divisions compete at the target effector. The balance of homeostasis is attributable to the competing inputs from the sympathetic and parasympathetic divisions dual innervation. At the level of the target effector, the signal of which system is sending the message is strictly chemical. A signaling molecule binds to a receptor that causes changes in the target cell, which in turn causes the tissue or organ to respond to the changing conditions of the body. Competing Neurotransmitters The postganglionic fibers of the sympathetic and parasympathetic divisions both release neurotransmitters that bind to receptors on their targets. Postganglionic sympathetic fibers release norepinephrine, with a minor exception, whereas postganglionic parasympathetic fibers release ACh. For any given target, the difference in which division of the autonomic nervous system is exerting control is just in what chemical binds to its receptors. The target cells will have adrenergic and muscarinic receptors. If norepinephrine is released, it will bind to the adrenergic receptors present on the target cell, and if ACh is released, it will bind to the muscarinic receptors on the target cell. In the sympathetic system, there are exceptions to this pattern of dual innervation. The postganglionic sympathetic fibers that contact the blood vessels within skeletal muscle and that contact sweat glands do not release norepinephrine, they release ACh. This does not create any problem because there is no parasympathetic input to the sweat glands. Sweat glands have muscarinic receptors and produce and secrete sweat in response to the presence of ACh. At most of the other targets of the autonomic system, the effector response is based on which neurotransmitter is released and what receptor is present. For example, regions of the heart that establish heart rate are contacted by postganglionic fibers from both systems. If norepinephrine is released onto those cells, it binds to an adrenergic receptor that causes the cells to depolarize faster, and the heart rate increases. If ACh is released onto those cells, it binds to a muscarinic receptor that causes the cells to hyperpolarize so that they cannot reach threshold as easily, and the heart rate slows.
Chapter 6: Autonomic Reflexes and Homeostasis | Anatomy & Physiology

Chapter 3: The nervous system. The nervous system comprises the central nervous system, consisting of the brain and spinal cord, and the peripheral nervous system, consisting of the cranial, spinal, and peripheral nerves, together with their motor and sensory endings.

It is autonomic because it functions subconsciously and involuntarily. Both branches innervate most organs in an arrangement called dual innervation. The parasympathetic division is most active during rest and stimulates digestive activities. The sympathetic division is most active during times of excitement and physical activity.

Animation Comparing Sympathetic and Parasympathetic Nervous Systems

The two divisions of the ANS work together to finely control the functions of the various organs so that they operate appropriately in different situations. The two systems often perform this control by working at cross purposes. So, for example, to precisely control the heart rate the sympathetic division will increase it while the parasympathetic decreases it.

Anatomy of the ANS

The commands of the ANS leave the central nervous system and go to effector organs by means of two efferent neurons arranged in series. The first neuron preganglionic neuron synapses with the second neuron postganglionic neuron at an autonomic ganglion. Preganglionic neurons of the sympathetic nervous system originate in the region of gray matter in the thoracic and upper lumbar region called the lateral horn. Pre- and postganglionic neurons are arranged in three patterns: The preganglionic neuron leaves through the ventral root. After the ventral and dorsal roots fuse to form the spinal nerve the preganglionic neuron goes to sympathetic ganglia that are connected to one another and run parallel to the spinal column on either side. The chain of ganglia is the sympathetic chain or sympathetic trunk. The preganglionic neuron is myelinated and the axons of these form the white ramus pl. The postganglionic neurons are unmyelinated and leave the ganglion as the gray ramus which rejoins the spinal nerves. Because the axons of the preganglionic neurons may branch and travel up and down the sympathetic chain, a single preganglionic neuron can synapse with many postganglionic neurons up and down the sympathetic chain. Hence, the effects of stimulation are widespread. A group of long preganglionic neurons innervate modified postganglionic cells in the adrenal medulla called chromaffin cells. The effects of these hormones spread by the bloodstream are widespread. The preganglionic neurons synapse with postganglionic neurons in collateral ganglia. The preganglionic neurons leave the spinal nerve through the white rami but do not synapse with neurons in the sympathetic chain but continue to the collateral ganglia. The postganglionic neurons originating from the collateral ganglia travel to specific effector organs. For example, postganglionic neurons originating from the celiac ganglion innervate some of the digestive organs. Hence, the effects of stimulation by this route are more localized and discrete.

Anatomy of the Parasympathetic Nervous System

The preganglionic neurons originate in the brain stem or sacral spinal cord and are relatively long. The preganglionic neurons synapse with postganglionic neurons in ganglia near the effector organ or in the wall of the effector organ. The X is called the vagus and innervates much of the viscera including lung, heart, stomach, small intestines and liver. The parasympathetic neurons that originate from the sacral spinal cord join to form distinct pelvic nerves.

Autonomic Neurotransmitters

The peripheral nervous system uses two neurotransmitters: Acetylcholine is the most common. Neurons that release it are called cholinergic. Cholinergic neurons include all preganglionic neurons of the autonomic nervous system, postganglionic neurons of the parasympathetic nervous system and some postganglionic neurons sweat glands of the sympathetic nervous system. Norepinephrine is the other neurotransmitter and is released by neurons called adrenergic. Almost all sympathetic postganglionic neurons are adrenergic. Cholinergic Receptors There are two classes: Nicotinic receptors are found on cell bodies and dendrites of sympathetic and parasympathetic neurons, on chromaffin cells of the adrenal medulla and on skeletal muscle cells. These receptors are associated with cation channels that allow both potassium and sodium ions to pass through. These receptors are associated with depolarization of the postsynaptic cells. Muscarinic receptors are found on effector organs of the parasympathetic nervous system. These receptors are coupled to G proteins.
and may either be inhibitory or excitatory. Effector organs acted upon include heart and smooth muscles of the pupil and digestive tract. Adrenergic Receptors Table These receptors are coupled to G proteins that activate or inhibit second messenger systems. Norepinephrine or epinephrine binds to α2 receptors and activates an inhibitory G protein Gi that decreases activity of adenylate cyclase, decreasing synthesis of cAMP. YouTube Video α receptors tend to be excitatory. Whether a G protein is stimulatory or inhibitory does not predict the cellular response. The cellular response, such as muscle contraction or glandular secretion, may be either promoted or inhibited. Autonomic Neuroeffector Junctions Synapses between an efferent neuron and its effector organ is a neuroeffector junction. In contrast to typical axon terminals, neurotransmitters are released at swellings along the axon called varicosities. Transmitter is released at all the varicosities so its release is more widespread than at typical axon terminals. Regulation of Autonomic Functions The sympathetic and parasympathetic divisions of the autonomic nervous system often work in opposition in order to maintain homeostasis. Hence the competing influences of the sympathetic and parasympathetic divisions need to be balanced or regulated to achieve homeostasis. Most changes in the organ activity are controlled by visceral reflexes. These reflexes include the pupillary light reflex, accommodation, vomiting reflex, swallowing reflex, urination, defecation, erection and ejaculation. Higher centers that control autonomic function include the hypothalamus, pons and medulla oblongata. The hypothalamus exerts an overriding influence on autonomic functions. It initiates the flight-or-fight response by activating the sympathetic branch which has immediate widespread effects. The hypothalamus contains centers that regulate body temperature, food intake and water balance. The hypothalamus, in turn, receives input from the cerebral cortex and the limbic system which is concerned with the experience of emotions. Anatomy of Somatic Nervous System Somatic motor neurons originate in the ventral horn of the spinal cord. A single motor neuron innervates many skeletal muscle fibers. A motor neuron plus all the fibers innervated is a motor unit. Neuromuscular Junction The neuromuscular junction is the region where the motor neuron synapses with a skeletal motor fiber. The axon terminals of the motor neuron are called terminal boutons. Acetylcholine is stored and released here. The plasma membrane opposite the terminal bouton is called the motor end plate. The motor end plate is invaginated and contains nicotinic cholinergic receptors. Acetylcholinesterase is found in the synaptic cleft and terminates the excitatory signal. This triggers the release of acetylcholine by exocytosis. Acetylcholine binds to nicotinic cholinergic receptors at the motor end-plate opening cation channels. The action potential leads to contraction of the fiber.
Chapter 7: CHAPTER PERIPHERAL NERVE INJURIES

Key Points. 1. Quantitative and objective electrophysiological tests of sensory, motor, and autonomic function are reviewed as adjuncts to the International Standards for Neurological Classification of Spinal Cord Injury (ISNSCI) and the American Spinal Injury Association Impairment Scale (AIS) neurological assessment.

Abstract To assess pathophysiology in irritable bowel syndrome IBS. Methods IBS patients 3 male and 41 healthy females underwent: Results IBS subgroups C, D, M were similar in age, gastric and small bowel transit, satiation, GV, rectal compliance, sensory thresholds or pain ratings. Comprehensive physiological assessment may help optimize management in IBS. Different laboratories have reported on individual pathophysiological features of interest and have documented abnormal transit 2 â€“ 4 , colonic motility 5 , 6 , rectal sensation 7 , 8 , brain function on imaging studies 9 , 10 mucosal structure and function 11 â€“ 14 or, in some studies, low grade inflammation 15 â€“ However, few studies comprehensively appraised more than one or two putative mechanisms in a sufficiently large number of patients. Patients with IBS and rectal hypersensitivity also have gastric hypersensitivity 21 â€“ The prevalence of abnormal upper gastrointestinal motor functions in a large group of patients with IBS is unclear. In IBS, there are also patients with alteration of bowel function or mixed, IBS-M which may be identified by symptoms 24 ; however, little is known about the pathophysiology of this subgroup. Autonomic dysfunction has been described in IBS patients 25 â€“ 27 , though the associations with motor and sensory dysfunctions in the same patients are unclear. The aims of our study were: Patients were recruited from an administrative database of patients residing within miles of the Mayo Clinic based on their primary presentation with IBS. Questionnaire responses assessed the coexistence of other gastrointestinal symptoms, psychological disturbances, and the relationship of upper abdominal symptoms to meal ingestion. Forty-one female healthy controls underwent the same measurements and were concurrently recruited. The healthy participants had less than 4 positive only mild severity permissible out of 19 gastrointestinal symptoms on a screening questionnaire. The study was approved by the Mayo Clinic Institutional Review Board and informed consent was obtained from all participants. Eligibility criteria and allowable medications are detailed in the Appendix. Questionnaires and Symptom Number All participants filled in the following questionnaires: Symptom number was based on the number of positive symptoms among the following: For each one of these symptoms, a score of 1 was assigned. The analysis of the relationship of symptom number and pathophysiology was based on 3 groups for number of primary IBS symptoms endorsed: Assessment of Gastrointestinal and Autonomic Functions The methods used to measure gastrointestinal transit, gastric volumes, satiation, rectal compliance and sensation as well as autonomic function are provided in the Appendix on-line.. The association between phenotype the three IBS subtypes and controls and the physiologic responses except sensation thresholds, see below was assessed using analysis of covariance ANCOVA. Detailed description of statistical methods for all the endpoints and the sample size assessments are provided in the Appendix on-line. IBS subgroups were similar in age. Physical examination all performed by one experienced gastroenterologist [MC] identified features suggestive of pelvic floor dysfunction in 12 patients: They were referred to a physical medicine-based retraining program. Controls took SSRI predominantly for symptoms not related to depression, e.

Chapter 8: Motor, sensory, and autonomic function: With Charlotte Behan and Roger Barker - Oxford Scholarship

Cranial Nerves. The nerves attached to the brain are the cranial nerves, which are primarily responsible for the sensory and motor functions of the head and neck (one of these nerves targets organs in the thoracic and abdominal cavities as part of the parasympathetic nervous system).

Chapter 9: Autonomic nervous system - Wikipedia
Autonomic nervous system function is based on the visceral reflex. This reflex is similar to the somatic reflex, but the efferent branch is composed of two neurons. The central neuron projects from the spinal cord or brain stem to synapse on the ganglionic neuron that projects to the effector.