THE NERVE OF THAT DOG
Why does an injury to a peripheral nerve result in a flaccid paralysis, atrophy of muscles, tissue degeneration, and loss of sensation?

Why does a cord lesion anterior to this level often result in a spastic paralysis of the pelvic appendage?

Why does a cord lesion posterior to this level usually result in a flaccid paralysis of the pelvic appendages?

What symptoms would you expect to see with a vertebral injury posterior to the termination of the spinal cord?
I. The EXAMINATION OF THE SENSORY SYSTEM requires a knowledge of the course of the chief sensory paths from the periphery of the body to the brain. Tests for skin sensation may be carried out by palpation and pin pricking. Corresponding areas on both sides of the body should be tested for comparison. Attempts may be made to demonstrate complete loss of pain sensation (anesthesia), small degree of pain loss (hypesthesia), and localized exaggeration of pain (hyperesthesia). In testing superficial sensation, one should begin in the area of less sensation and move toward areas of greater sensation; e.g., pin prick from an anesthetic to a normal area or from a normal to a hyperesthetic area. Deep pressure pain may be manifested by pinching the Achilles tendon or pressure on the testicle or eyeball. Tests for deep sensation (proprioceptive) may be made by forced movements of the limbs, as placing them in abnormal positions or postures. Each organ of special sense may be examined specifically and individually.

II. The EXAMINATION OF THE MOTOR SYSTEM should include an inspection of the extremities and other organs that are under muscular control. Pathology of the bones, joints, or muscles must be excluded as the cause of lost function of the part. The posture of each limb should be noted, as well as the presence of muscle atrophy or hypertrophy. The muscles should be inspected, especially of the affected limb or limbs, for tonicity. Changes in muscle tone from the normal are characterized by a stiff, rigid state, or a loose, flaccid condition. Voluntary movements, if any, of the affected part or extremity should be observed; i.e., walk or run animal.

III. The EXAMINATION OF THE REFLEXES is discussed, beginning on page 6.
1. Spinous Process
2. Cranial Articular Process
3. Caudal Articular Process
4. Accessory Process
5. Transverse Process
6. Nucleus Pulposus
6'. Fibrous Ring
6'. Dorsal Longitudinal Ligament
7. Epidural Space
8. Subarachnoid Space
9. Dura Mater
10. Arachnoid
11. Longitudinal Vertebral Sinus
12. Ventral Root
13. Dorsal Root Ganglion
14. Spinal Nerve
15. Dorsal Branch
16. Ventral Branch
17. Ramus Communicans
18. Sympathetic Trunk Ganglion
STRUCTURE OF THE NERVOUS SYSTEM

The NEURON, consisting of the nerve cell body and all its processes (fibers), is the structural and functional unit of the nervous system.

Any injury which severs a nerve fiber will result in degeneration of that part of the fiber separated from the cell body.

The NERVOUS SYSTEM, (for the purpose of description only), may be subdivided into:

I. The CENTRAL NERVOUS SYSTEM, consisting of the brain and the spinal cord; and -

II. The PERIPHERAL NERVOUS SYSTEM, consisting of (in the dog) -

   a) 12 pairs of Cranial Nerves and their ganglia.

   b) 36 pairs of Spinal Nerves and their ganglia (8 Cervical, 13 Thoracic, 7 Lumbar, 3 Sacral, and 5 Coccygeal nerves).

   c) Autonomic Nervous System, with Sympathetic and Parasympathetic components, is intricately associated with the cranial and spinal nerves, but differs in function (involuntary regulation of activity of smooth muscle, heart muscle, and glands) and in the details of structure (2 neuron chain), and distribution (usually a dual control, inhibition and acceleration, for each visceral organ).
A SPINAL NERVE INJURY AFFECTS THESE KINDS OF FIBERS
A PERIPHERAL NERVE trunk is composed of many nerve fibers which are of two fundamental functional types -

1. **SENSORY** or **AFFERENT FIBERS** carry impulses to the brain and spinal cord. These fibers are stimulated by means of receptors (cells or groups of cells in peripheral areas which are specifically sensitive to various types of stimuli).
   
a) Exteroceptors are receptors that are sensitive to touch, pressure, pain, temperature, odors, gustatory agents, sound, and light.

b) Proprioceptors are receptors that are sensitive to tension, pressure, and position changes in muscles, ligaments, tendons, bones, and joints.

2. **MOTOR** or **EFFERENT FIBERS** carry impulses from the brain or spinal cord to effector organs (muscles or glands).
   
a) Somatic efferent fibers supply the striated muscles of the body.

b) Visceral efferent (autonomic) fibers supply the smooth muscle, the cardiac muscle, and the glands of the body.

The Symptoms or Signs of an Injury to a Peripheral Nerve are but a reflection of the types of fibers that are contained in that nerve (see drawing, page 4). A nerve injury is manifested by an impairment of neurologic function in motor, sensory and trophic spheres.

1. Motor loss results in a flaccid paralysis (muscles have no tone - soft and flabby).

2. Sensory involvement may result in pain (due to partial or irritative lesions) or the loss of various sensations (analgesia, anesthesia, etc.).

3. Trophic disturbances are related to impaired nutritional and metabolic activities in tissues which are partly under neurogenic control. These disturbances include slow healing of wounds, ulcerations, muscle atrophy, degeneration of bones, joints, etc.
THE ANATOMY OF REFLEXES

1. A receptor, such as a special sense organ, cutaneous end organ, or a neuromuscular spindle, the stimulation of which initiates an impulse.

2. The afferent (sensory) neuron, which transmits the impulse through a peripheral nerve to the central nervous system, where synapse occurs with a connecting neuron.

3. A connecting neuron, which relays the impulse to the efferent neuron.

4. The efferent (motor) neuron, known as the lower motor neuron, passes outward in the nerve trunk and delivers the impulse to an effector.

5. An effector, either a muscle or a gland, produces the response.

Reflexes are inborn stimulus-response mechanisms. The instinctive behavior of lower animals is governed largely by reflexes; in higher animals, such as the dog, behavior is more a matter of conditioning, and reflexes are subordinated as basic defense mechanisms. Reflexes can be utilized for the purpose of localizing pathologic processes in the brain, the spinal cord, and the peripheral nervous system.

Remember that a reflex is a test of both the afferent and the efferent limbs of the arc, which may be carried in different peripheral nerves (i.e., scratch reflex; corneal reflex). Interruption of the reflex arc at any point will abolish the response.
THE UPPER AND THE LOWER MOTOR NEURONS

MOTOR AREA OF CORTEX

SENSORY AREA OF CORTEX

THALAMUS

EXAMPLE OF A SENSORY FIBER IN AN ASCENDING TRACT

EXAMPLE OF AN UPPER MOTOR NEURON IN A DESCENDING TRACT

THE LOWER MOTOR NEURON
The LOWER MOTOR NEURON (see drawing on page 7) is the essential motor cell concerned with skeletal muscle activity. The lower motor neuron is the "final common pathway," because, even though it is acted upon by fibers from the brain (corticospinal, rubrospinal, vestibulospinal, reticulospinal, tectospinal) as well as by intrasegmental and intersegmental reflex neurons in the spinal cord, it is the ultimate pathway through which neural impulses reach the muscle.

Lesions affecting the lower motor neurons may be located in the cells of the ventral gray column of the spinal cord, or in the brain stem for the cranial nerves, or in their axons which are contained in the peripheral nerves.

| Symptoms of lower motor neuron lesions include flaccid paralysis of the involved muscles, muscle atrophy, and tissue degeneration. Reflexes of the involved muscles are absent, and no pathologic reflexes are obtainable. Injury to a peripheral nerve, then, evidences a lower motor neuron paralysis as well as the loss of sensation from the part of the body supplied by that nerve. |

The UPPER MOTOR NEURONS convey impulses from the brain to the lower motor neurons and are essential to normal voluntary muscular activity. Their axons pass down the spinal cord in descending tracts such as the corticospinal tract to synapse with the lower motor neurons. Lesions of the upper motor neurons may be located anywhere in the brain or the spinal cord above the level of the lower motor neurons with which they synapse.

The brain of higher animals has developed into a central regulating mechanism which is concerned with initiating and integrating the reflex arcs of basic limb movements which have been laid down in the spinal cord. Since the lower motor neurons are normally under partial inhibition by the higher centers in the brain, an upper motor neuron paralysis releases this inhibition and exaggerated spinal reflexes result.

| Symptoms of upper motor neuron lesions include spastic paralysis of the involved muscles, little or no muscle atrophy (other than atrophy of disuse), and hyperactive deep reflexes, and the presence of pathologic reflexes. Conscious perception of sensations (such as pain, etc.) is also lost when lesions involve the sensory pathways in the cord or brain. |

Spinal shock refers to the depression of reflexes that follows soon after spinal cord transection, and is believed to be due to loss of stimulation from higher levels. Spinal shock is usually transient (an hour or so in the dog), and is followed by a period of increased reflex response.
REFLEXES UTILIZED IN THE NEUROLOGIC EXAMINATION OF THE DOG
Extracted from McGrath

I. SPINAL REFLEXES

The reflex arcs of basic limb movements have been laid down in the spinal cord. They are segmental (local) reflexes of the cord, and may be demonstrated in normal animals and in animals with a severed cord, providing the transection of the spinal cord does not involve the level of the reflex.

Normal Spinal Reflexes:

1. The Flexor Reflex - Pressing or pinching of the foot pad results in a flexion of the limb at all joints. Segments of the cord involved in the reflex:

   Hind limb: Lumbar 4-5-6-7, Sacral 1-2-3.
   Forelimb: Cervical 6-7-8, Thoracic 1-2.

2. Knee Jerk - Tapping the patellar ligament which connects the patella with the tibia results in a sharp contraction of the extensor muscles of the stifle joint. Segments of the cord involved in this reflex:

   Hind limb: Lumbar 4-5-6.

3. Extensor Thrust Reflex - Applying pressure to the pad of the paws so as to spread the toes slightly results in a quick extension (thrust) of the limb. Segments of the cord involved in this reflex:

   Hind limb: Lumbar 4-5-6-7, Sacral 1.
   Forelimb: Cervical 6-7-8, Thoracic 1.

Clinical Evaluation of Spinal Reflexes:

The spinal reflexes are of particular clinical significance in the dog presented with paresis or paralysis of a limb or limbs. With the exception of local limb pathology, such as a fracture of a long bone, arthritis, etc., such symptoms are most commonly the result of pathology of the vertebral column.

a) If the hind limb reflexes are depressed or absent, the lesion usually is localized in the lower lumbar area. Roentgen examination should include the lumbar region from L4 posteriorly.

b) In such an animal, the hind limb reflexes may be more depressed or absent on one side. This then suggests an ipsilateral or same side lesion. If X-ray examination is carried out, lateral views of the lower lumbar vertebra with the affected side down are indicated.
c) If the hind limb spinal reflexes are present, this indicates pathology of the anterior lumbar or thoracic spine. Exaggerated reflex reaction in the hind limbs usually implies rather extensive cord pathology in the anterior lumbar or thoracic cord, the exaggerated response being a type of release phenomenon (see upper motor neuron paralysis).

d) Occasional animals are presented with spastic paraplegia in which the flexor reflex and knee jerk are difficult to elicit due to extreme extensor hypertonicity. This is seen especially in dogs with herniated intervertebral discs between T2 - L3. If there is cord compression and irritation, the extensor spasticity usually suggests an incomplete cord lesion.

The forelimb reflexes should always be examined in the dog presented with forelimb paresis or paralysis, and especially in animals manifesting tetraplegia, prostration, or bilateral foreleg paralysis. Foreleg paralysis is observed most commonly in association with traumatic injury of the radial nerve, brachial plexus, or spinal cervical roots. Peripheral nerve involvement is usually characterized by a complete motor and sensory loss. Animals evidencing forelimb paresis or paralysis due to more central pathology rarely show the marked neurologic deficit of the traumatic peripheral syndrome. Bilateral forelimb paralysis and tetraplegia usually imply more centrally, rather than peripherally located lesions.

a) Depression or absence of the forelimb reflexes usually implies a lesion involving C6-7-8; T1. Unilateral depression or absence of forelimb reflexes suggests an ipsilateral or same side lesion of the spine.

b) In the animal with bilateral foreleg paralysis and/or tetraplegia, the presence or exaggeration of the forelimb reflexes suggests a vertebral column or chord lesion in the anterior cervical area or above C6 (see upper motor neuron paralysis).

At the initial examination, spinal reflexes or any neurologic reflex has a minimal value for prognosis. If depressed or absent reflexes gradually increase and improve with time, a suggestion of prognostic improvement may be given. In most cases multiple neurologic examinations in the same animal are essential for prognostic interpretation.

Abnormal Spinal Reflexes:

1. The Crossed Extensor Reflex - In the recumbent animal, flexion of one limb in response to pinching the foot pad (flexor reflex) is accompanied by extension of the opposite or contralateral limb. This is an obvious spinal reflex to compensate for the (theoretical) loss of support by the flexed limb. This reaction rarely is observed under clinical conditions, but when present, is indicative of an extensive transverse cord lesion.

2. The Scratch Reflex - The scratching movement of flexion and extension of the hind limb occurs when a stimulus is applied to the flank and shoulder area of the animal. In a spinal animal, (low cervical transection) the reflex will always occur, providing an adequate stimulus is supplied. The reflex may be elicited in a normal animal; however, it can not be predicted as to whether or not it will occur. The brain may inhibit the lower motor neurons and prevent the movement in the normal animal.
Spinal Visceral Reflexes:

Micturation, although essentially reflex in nature, is initiated usually by an effort of the animal's will. There are several nerve centers in the spinal cord (especially the sacral segments) that are concerned in the micturation reflexes, but the volitional act of micturation is integrated at higher levels of the central nervous system, namely the hypothalamic area and the cerebral cortex.

Lesions of the spinal cord of the dog, regardless of location, may be associated with disturbances of urination. Most typically, there is at first retention followed by incontinence. The retention of urine or continual residual urine in the bladder may lead to inflammation or cystitis.

The colon and rectum may also be affected by spinal cord pathology. Such signs as fecal retention or incontinence are observed frequently with low lumbar or sacral spinal cord lesions. See pelvic and pudendal nerves on page 23.

II. ATTITUDINAL AND POSTURAL REACTIONS

These are a group of reactions which maintain various parts of the animal's body in harmonious relationship, even though different attitudes and postures may be assumed. In general, these reactions depend on the continuity of an intact nervous system; the brain as well as the spinal cord is involved in the completion of the reflex.

1. Tonic Neck Reflexes.
   Passively flexing or raising the head dorsally, so as to bend the neck upward causes increased extension in the forelimbs and partial flexion in the hind limbs. Ventral head flexion should result in semi-flexion of the forelimbs and extension of the hind limbs.

2. Supporting Reactions.
   The animal is held so that the hind limbs may be lowered to the ground. They normally should stiffen in extension and support the weight as the paws touch the ground. If hind limb spinal reflexes are present, but there is an absence of this reaction, it indicates a lesion anterior to the third lumbar cord segment.

3. Righting Reaction
   The ability to remain right side up is a universal property of animals. Receptors for perception of changes in position of the head are located in the inner ear. The centers for universal righting reflexes lie chiefly in the medulla and midbrain, and in the cerebral cortex for optical righting reflexes.

   a) Drop animal upside down to see if it can land on its feet.
   b) Lift animal by the pelvis to see if the head is held in a normal position as the body is turned from one side to the other, or if the head is simply allowed to hang down.
   c) The animal is placed forcibly on its side to see if it will right itself.
The righting reactions are especially abnormal with vestibular pathology, such as a middle ear infection and focal lesions of the vestibular nuclei or tracts. In these animals, abnormalities of the righting ability are manifested by head tilts, rolling movements, etc.

A primary requirement for normal standing is that the feet should be placed in the proper position to bear weight. When the animal is lowered toward a supporting surface, visual and/or various exteroceptive and proprioceptive stimuli resulting from contact with a supporting surface elicit a placing reaction (the legs are brought from a non-supporting pose into a standing position).

a) Lower the animal toward the ground to see if the feet are positioned properly to bear weight.

b) Hold animal in the air with one hand under the thorax and the other hand under the muzzle so as to elevate the head to exclude vision. With the forelegs hanging free and dependent, move the animal forward toward the edge of a table to make contact with the front of the forepaws. The slightest contact of the paws with the table should result in an immediate and accurate placing of the feet, soles down, on the table surface.

The placing reaction may be initiated by tactile or visual stimuli. Disturbances in the normal response may occur with the lesions located anywhere in the sensory or motor arc (peripheral nerves, spinal cord, brain stem, and cerebrum).

5. Hopping Reactions.
These are essentially corrective movements of the legs which serve to maintain a standing posture under conditions involving displacement of the body in the horizontal plane. Hold the animal so that it stands on one leg. On movement of the body forward, backward, or to either side, the leg hops in the direction of the displacement so that the foot is kept directly under the shoulder or the hip.

The hopping reaction may be evaluated in a similar manner as the placing reaction. This is essentially a proprioceptive reaction to changes in the body gravity.

III. CRANIAL NERVE REFLEXES are indicated with the Cranial Nerves, page 14.
I. Olfactory N.
II. Optic N.
III. Oculomotor N.
IV. Trochlear N.
V. Abducens N.
VI. Abducens N.
VII. Facial N.
VIII. Acoustic N.
VIIIa. Cochlear N.
VIIIb. Vestibular N.
IX. Glossopharyngeal N.
X. Vagus N.
XI. Spinal Accessory N.
XII. Hypoglossal N.
THE CRANIAL NERVES

I. **OLFACTORY N.** - Rhinitis may involve the brain directly, because the subarachnoid space follows along the olfactory nerve fibers through the cribriform plate to the olfactory area of the nasal cavity.

Signs of paralysis and/or tests - In dogs, cloves, lavender, anise, asafetida, benzol, and xylol appear to stimulate only the olfactory organs.

II. **OPTIC N.** - This cranial nerve can be examined directly with an ophthalmoscope (Papilledema, optic atrophy, detached retina, etc.). The cerebral dura and underlying arachnoid with its cerebrospinal fluid-filled space surrounds the optic nerve up to the sclera (eye enucleation).

Signs of paralysis and/or tests - Retinal Reflex (afferent arm of) - throw cotton ball at plastic sheet held before the eyes. (Air currents must be eliminated to exclude blinking caused by a corneal reflex.)

III. **OCULOMOTOR N.** - motor to most of eye muscles (dorsal, medial, ventral, recti, ventral oblique). Motor to levator palpebrae muscle (which elevates the upper eyelid). Parasympathetic fibers in this nerve supply the ciliary muscle (accommodation) and the constrictor muscles of the pupil.

Signs of paralysis and/or tests - Paralysis results in drooping of the upper eyelid, dilatation of the pupil, and deviation of the eyeball to the lateral side and downward. Pupillary reflex (efferent arm of) - Normal pupil constricts in response to light shined into eye.

IV. **TROCHLEAR N.** - motor to the dorsal oblique muscle. Paralysis moves the axis of vision upward and inward.

V. **TRIGEMINAL N.** - in general is sensory from the skin and most of the deeper structures of the head, and is motor to the muscles of mastication.

1. **Maxillary N.** - sensory from lower eyelid, roof of oral cavity, upper teeth, nasal cavity, skin of nostrils and upper lip.

   Test for sensation from above areas by palpation, pinching, or pin pricking.

2. **Ophthalmic N.** - sensory from upper eyelid and medial canthus, eyeball, posterior part of nasal cavity, frontal region including sinus, skin of caudal part of "nose."

   Test for sensation from above areas - Corneal reflex (afferent arm of) - Air current from syringe directed at cornea from the lateral canthus of eye (out of field of vision) normally results in blinking. (Vision must be excluded to eliminate the retinal reflex.)

3. **Mandibular N.** - sensory from floor of oral cavity, cheeks, lower lip, lower teeth, anterior two-thirds of tongue (not taste), skin of the lateral cranium and base of ear. Motor to the muscles of mastication.

Signs of paralysis and/or tests - Test for sensation from above areas. Ability to chew is impaired. Unilateral motor paralysis may result in slight deviation of lower jaw toward the normal side; bilateral paralysis results in a dropped jaw (dumb rabies). The masseter and temporal muscles may atrophy.
VI. **ABDUCENT N.** - motor to the lateral rectus and retractor muscles. 
Paralysis results in rotation of the eyeball toward the medial canthus.

VII. **FACIAL N.** - Passes along the roof of the middle ear and is thus vulnerable in middle ear infections. It is **motor** to the muscles of facial expression (ears, lips, cheeks, eyelids). **Sensory** (for taste) from anterior two-thirds of tongue. Parasympathetic fibers in the facial nerve supply all the glands of the head except the parotid salivary gland.

Signs of paralysis and/or tests - In a complete paralysis, all the superficial muscles of the head are flaccid. The ear droops, the eyelid remains open, the normal lines around the cheeks, muzzle, and face are smoothed out. Eyelid can not close when the corneal or retinal reflexes are tested. This is essentially a motor paralysis and except for taste, there is no loss of sensation from the skin and mucous membranes.

VIII. **ACOUSTIC N.** - in reality, is composed of two separate nerves, the cochlear and the vestibular.

1. **Cochlear N.** transmits impulses which originate in the cochlea, a part of the inner ear, which is a specialized receptor for sound.
   
   Signs and/or symptoms of paralysis - Deafness is rather easily tested by calling the dog's name or noting its reaction to various noises, i.e., hold watch near ear, but out of animal's field of vision.

2. **Vestibular N.** begins with receptors in the utricle, saccule, and the ampullae. It transmits proprioceptive impulses initiated by changes in position of the head. The entire vestibular mechanism is an important dynamic apparatus which is continually discharging stimuli into the nerves which supply skeletal musculature, i.e., head tilt with middle ear infection.
   
   Signs and/or symptoms of paralysis - Symptoms may include nystagmus, head tilt, rolling movements, circling, hypotonia or hypertonia, incoordination, and prostration. Postural and attitudinal reflexes are abnormal.

IX. **GLOSSOPHARYNGEAL N.** - Motor (with Vagus N.) to muscles of pharynx. 
**Sensory**, including taste, from root of tongue, pharynx, tonsils, middle ear, carotid sinus. Parasympathetic fibers in this nerve supply the parotid salivary gland.

Signs and/or symptoms of paralysis - Loss of sensation from pharynx, root of tongue. Pharyngeal (gag) reflex is lost on affected side. Some difficulty in swallowing will be noted. The carotid sinus reflex has its afferent arm in this nerve. Pressure over the sinus normally produces slowing of the heart and a fall in blood pressure.

X. **VAGUS N.** - Motor and sensory to the larynx and (with Glossopharyngeal N.) to the pharynx and soft palate. Sensory from part of external ear canal and from thoracic and abdominal viscera. Parasympathetic fibers in this nerve supply the thoracic and abdominal organs, causing slower heart rate, constricted bronchioles, increased bronchial secretion, increased peristalsis, relaxation of pyloric sphincter, stimulation of (digestive) glandular secretion.
Signs and/or symptoms of paralysis - Loss or impairment of voice. Dyspnea due to flaccid vocal cords. Difficult swallowing associated with regurgitation of fluids through nostrils. Paralysis of soft palate and loss of gag reflex. Cough is a constant symptom of vagal irritation. Dilatation of stomach, tachycardia, etc., may result from vagal paralysis, while diarrhea may result from vagal irritation. (An interesting example of referred "pain" is the vomiting done by a young dog with an ear inflammation. Since the vagus is sensory from both the external ear canal and the stomach, the dog may vomit because the brain fails to distinguish the true source of the irritation.)

XI. (SPINAL) ACCESSORY N. - part of this nerve is distributed with the vagus while the spinal portion is motor to the trapezius and part of the sternocephalicus and brachiocephalicus muscles. Nerve injury is manifested by signs of weakness, paralysis, and atrophy of the involved muscles.

XII. HYPOGLOSSAL N. - motor to the muscles of the tongue. Injury to the nerve causes paralysis of one-half of the tongue. When the tongue is protruded, it deviates toward the paralyzed side. The muscles on the affected side of the tongue atrophy.
Medial View of Forelimb

illustrating the relative course and distribution of the major nerves to the front leg of the dog.
THE MAJOR NERVES OF THE FORELIMB

The nerves of the forelimb arise from the brachial plexus. The brachial plexus is formed by the ventral branches of the last 3 Cervical and the first 2 Thoracic nerves (C6-7-8, T1-2).

**SUPRASCAPULAR NERVE** - 6th (7) Cervical components.

**Motor** - to supraspinatus and infraspinatus muscles.

**Signs of Paralysis** - The loss of extensor action by these muscles on the shoulder is difficult to detect. These muscles serve largely as lateral ligaments for this joint. Atrophy is pronounced and the spine of the scapula becomes prominent (Sweeny).

**AXILLARY NERVE** - (6) 7th (8) Cervical components.

**Motor** - to certain flexors of the shoulder (teres major, teres minor, deltoideus, part of subscapularis muscle).

**Sensory** - from the skin of the dorsolateral aspect of the true arm or brachium.

**Signs of Paralysis** - Small area of cutaneous desensitization on the lateral side of the arm, but there is no pronounced loss of flexion of the shoulder joint. (Flexion of the shoulder apparently can be accomplished by the synergistic action of such muscles as the long head of the triceps and the latissimus dorsi.)

**Test** - Flexor Reflex (shoulder) weakened in axillary paralysis.

**RADIAL NERVE** - 7th 8th Cervical, 1st 2nd Thoracic components.

The entire radial nerve may be injured by fractures of the first rib or traumatic avulsion of its roots from the spinal cord.

**Motor** - to all the extensor muscles of the elbow, the carpus, and the digits.

**Sensory** - from the skin on the dorsal and lateral parts of the forearm and the dorsal aspect of the paw.

**Signs of Paralysis** - The leg can bear no weight when the entire radial nerve is injured. This is primarily due to the paralysis of the extensors of the elbow. This joint remains flexed when walking. When the nerve is injured distal to the branches which supply the triceps muscle, the paralysis is much less marked. Fractures of the humerus may easily involve this part of the radial nerve. The elbow can be extended, but there is a tendency to knuckle over onto the dorsal side of the paw when walking. After a time, the paralysis may be difficult to detect, but the cutaneous desensitization is diagnostic.

**Test** - Extensor Thrust Reflex, Supporting and Placing Reactions are absent in radial paralysis.
MUSCULOCUTANEOUS NERVE - 7th Cervical component.

**Motor** - to special flexors of the elbow joint (biceps and brachialis muscles).

**Sensory** - from the skin on the medial side of the forearm. An anastomotic branch joins the median nerve and is distributed with it.

**Signs of Paralysis** - Paralysis of this nerve causes little change in gait. There appears to be a slight straightening of the angle of the elbow joint. With some difficulty, the elbow can still be flexed (as when raising the paw to the edge of the table). This ability is probably due to the flexor action on the elbow joint by the extensor muscles of the carpus and digits which originate on the humerus. Skin is desensitized on the medial side of the forearm.

**Test** - Flexor Reflex (elbow) weakened in musculocutaneous paralysis.

MEDIAN AND ULNAR NERVES - 8th Cervical, 1st 2nd Thoracic components.

**Motor** - to all the flexor muscles of the carpus and digits.

**Sensory** - (together with the anastomotic branch of the musculocutaneous nerve) from the skin and pads on the volar side of the paw. Sensation from the skin on the caudal side of the forearm and the dorso-lateral aspect of the 5th digit is mediated solely by the ulnar nerve.

**Signs of Paralysis** - Loss of both these nerves causes little alteration of gait. There is some sinking of the carpus and fetlock due to the loss of tone to the flexors of these joints. Injury to the ulnar nerve does cause desensitization in the areas which are supplied solely by it. The volar aspect of the paw is completely desensitized only when 3 nerves, the median, the ulnar, and the musculocutaneous are injured. **Active** flexion of carpus is lost.
Medial View of Hindlimb

illustrating the relative course and distribution of the major nerves to the hind leg of the dog.
THE MAJOR NERVES OF THE HINDLIMB AND PELVIS

The nerves of the hindlimb arise from the lumbosacral plexus. The lumbosacral plexus is formed by the ventral branches of the last 4 Lumbar and the 3 Sacral nerves (L4-5-6-7, S1-2-3).

OBTURATOR NERVE - (4) 5th 6th Lumbar components. It is vulnerable to trauma as it courses down the shaft of the ilium.

Motor - to the muscles which adduct the thigh (external obturator, pectineus, adductor, and gracilis muscles).

Signs of Paralysis - The pelvic appendage slides laterally on a smooth surface in a unilateral obturator nerve injury. The animal literally "does the splits" on such a surface, with a bilateral obturator nerve lesion. The animal walks quite normally on a "non-skid" surface.

FEMORAL NERVE - 4-5-6 Lumbar components.

Motor - the major extensors of the stifle joint (quadriceps femoris) and to the iliopsoas and sartorius muscles.

Sensory - saphenous branch is sensory from the skin on the medial surface of the thigh, stifle, leg, and paw.

Signs of Paralysis - The stifle joint can neither be extended nor fixed to prevent the collapse of the leg when bearing weight. (The stifle is the key joint of the hindlimb.) When walking, the dog must take a quick step with the unaffected leg to prevent the complete collapse of the paralyzed leg while it is bearing weight. Desensitization occurs in the area supplied by the Saphenous branch of the Femoral nerve.

Test - Extensor Thrust (stifle).

PERONEAL OR FIBULAR NERVE - a terminal branch of Sciatic nerve, is vulnerable to trauma as it crosses the lateral aspect of the stifle joint quite superficially.

Motor - to the muscles which flex the hock and extend the digits.

Sensory - from the dorsal aspect of the distal part of the true leg, the hock, and the paw.

Signs of Paralysis - Lesions of this nerve result in a straightening of the hock and a tendency for the dog to knuckle over onto the dorsum of the fetlock and digits. Although the hock can not be flexed, the dog soon learns to place the foot properly by a greater flexion of the hip and extension of the stifle joints. The dorsal aspect of the paw is anesthetized in this paralysis.

Test - Flexor Reflex (hock).
TIBIAL NERVE - a terminal branch of Sciatic nerve, descends in contact with the caudal aspect of the stifle joint.

**Motor** - to the muscles which extend the hock and flex the digits.

**Sensory** - from the skin and pads on the plantar aspect of the paw.

**Signs of Paralysis** - The hock joint remains flexed when the dog is walking, and, when weight is supported on the affected limb, this flexion is accentuated. Sensation is lost from the plantar aspect of the hind paw.

**Test** - Extensor Thrust Reflex (hock).

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SCIATIC NERVE - (5) 6th 7th Lumbar, 1 (2) Sacral components. This nerve is vulnerable within the pelvic cavity (pressure, fractures of the ilium), and it is endangered by trauma and surgical procedures near the proximal end of the femur. Irritating injections into the caudal thigh muscles may also involve this nerve.

**Motor** - The peroneal and tibial nerves which have already been described are the two terminal branches of the sciatic nerve. In addition, this large nerve supplies the massive caudal thigh muscles which help to extend the hip and flex the stifle joints. Branches given off within the pelvis supply the gluteal and other muscles which extend and abduct the hip.

**Sensory** - In addition to sensory components of the tibial and peroneal nerves, the sciatic nerve innervates the skin on the caudal and lateral sides of the true leg.

**Signs of Paralysis** - Cutaneous desensitization exists below the stifle except for the medial side of the leg, hock, and paw (this via Femoral N.). The gait is markedly altered by paralysis of the muscles to all the joints below the stifle; only the extensors of this joint remain functional. When the sciatic nerve is injured at the level of greater sciatic foramen, the hock of the affected leg aimlessly and passively flexes and extends as weight is shifted on the appendage. The leg does not collapse when bearing weight because the femoral nerve fixes the stifle joint. The animal stands "knuckled over" on the dorsal side of the paw. The hip joint remains functional, despite the paralysis of the caudal thigh muscles. The action of this joint is apparently maintained by the gluteal, obturator, and femoral nerves. Injury to the entire sciatic nerve within the pelvic cavity would include the branches to the gluteal and to the small pelvic association muscles. In addition to the symptoms described above, paralysis of these extensor and abductor muscles of the hip would result in flexion of the hip joint and the drawing of the affected limb toward the midline. (Only the femoral and the obturator nerves remain functional.)
PUDENDAL NERVE - 1-2-3 Sacral components.

Motor - to external anal sphincter and the skeletal muscles associated with the penis, vulva, and urethra.

Sensory - from penis or clitoris, and the skin of the anal opening, the vulva, and part of the scrotum.

Signs of Paralysis - Anesthesia in the areas indicated above. Relaxed external anal sphincter.

Test - Anal Reflex (touching skin near anal orifice normally results in visible contraction of anal sphincter.

PELVIC NERVE - those fibers in 1-2 Sacral components which are parasympathetic unite to form the pelvic nerve.

Motor - to the smooth muscle and glands of the pelvic cavity (rectum, bladder, etc.) which, upon contraction, cause urination, defecation, and erection.

Sensory - from the pelvic viscera.

Signs of Paralysis - Absence or alteration of pelvic visceral reflexes (urination, defecation), and erection.