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Forelimb and Hindlimb Innervation

Context: Cutaneous zones are areas of the skin that are innervated by more than one peripheral nerve. An autonomous zone is an area of skin that is served by a single nerve. As such, we can use autonomous zones to test the sensory function of individual peripheral nerves. One of the ways we can test the sensory and motor components of many peripheral nerves is through reflex testing. A reflex is an involuntary, automatic response to a specific stimulus. Reflex activity is important for normal locomotion to occur but clinically we can test several different reflexes to assess the integrity of the peripheral and central nervous system. There are two activities in this active learning session intended to facilitate understanding of these important concepts.

Learning Objectives: By the end of this session, students should be able to:

- ☐ Differentiate between a cutaneous zone and an autonomous zone.
- ☐ Identify the autonomous zones in the forelimb of the dog.
- ☐ Identify the autonomous zones in the hindlimb of the dog.
- ☐ Describe how autonomous zones are utilized in a clinical setting to assess nerve function.
- ☐ Describe the sensory and motor nervous system anatomy involved in assessing the thoracic limb withdrawal, pelvic limb withdrawal and patellar reflexes.

General Instructions:

1. Complete the learning objectives

Autonomous Zones (Activity 1)

Autonomous zones station Instructions:

1. Create stockinettes of the autonomous zones of the forelimb and hindlimb with the markers provided.
2. Place these stockinettes on a stuffed dog.
3. Describe the location of each autonomous zone using common and anatomical terminology.
4. Complete the learning objectives.
5. Take the autonomous zone stockinettes with you for future use.

Reflex Station (Activity 2)

Background information: This is an introduction to three of the neurologic reflex tests commonly done in small animal clinical practice. There are many neurologic tests that are used to localize lesions and these will be covered in your Neuroanatomy and Companion Animal Medicine courses.

The reflex pathways of the forelimb and hindlimb utilize the portions of the spinal cord from which the peripheral nerves originate from. Testing limb reflexes involves inducing a sensory stimulus which is transmitted to the CNS via a sensory neuron. As we have discussed before, the cell body of this sensory neuron is in a dorsal root ganglion. The sensory signal will travel from the receptor detecting the stimulus, through a peripheral nerve, to a spinal nerve, to the dorsal root, then terminate on an interneuron in the dorsal horn gray matter. There - magic happens! Through connections you'll study later in the curriculum, this sensory input will lead to activation of alpha motor neurons in the ventral horn gray matter in the same region of the spinal cord. The motor output will travel through the ventral root, to the spinal nerve, to the peripheral nerve, and then finally to the target muscle to cause "reflexive" contraction. Clinically this is visualized as an expected movement of the limb which may involve one or multiple muscle groups and joints.

Reflex station instructions:

- ☐ Use the diagrams and tables provided to answer questions on the anatomy involved in several reflexes that are often assessed in small animal clinical practice listed above.
- ☐ Complete the session's learning objectives.

Videos: https://www.youtube.com/watch?v=BzaY5lRWr70 - Thoracic Limb withdrawal (This video includes both thoracic and pelvic limb withdrawal reflexes).

https://www.youtube.com/watch?v=BxcmwKV_VyI - Pelvic Limb withdrawal

https://www.youtube.com/watch?v=NFqFABsIa7Q - Patellar reflex (1:57 minutes into the video)

Reflex # 1: Watch the Thoracic Limb Withdrawal Video

- If you were to perform the withdrawal reflex test on the **forelimb** by pinching the skin on the **lateral surface of the 5th digit** on the front paw.
    - What peripheral nerve will transmit the sensory input?
    - What peripheral nerve(s) will transmit the motor output? (hint: which joints are flexing?)
    - What would change if you pinched the skin of the 2nd digit instead?

Reflex # 2: Watch the Hindlimb Withdrawal Video

- If you were to perform the withdrawal test on the hindlimb by pinching the skin on the **dorsal surface of the 3rd digit** on the hind paw.
    - What peripheral nerve will transmit the sensory input?
    - What peripheral nerve(s) will transmit the motor output? (hint: which joints are flexing?)
    - What would change if you pinched the skin on the plantar surface of the same digit?

Reflex # 3: Watch the Patellar Reflex Video (1:57 minutes into the video)

This reflex is tested by first locating the stifle and the patellar ligament. The stifle should be in a relaxed and slightly flexed position, then using a pleximeter (reflex hammer) the patellar ligament is gently tapped.

- If you were to perform the patellar reflex test on the non-dependent hindlimb (the limb furthest from the ground).
    - What peripheral nerve will transmit the sensory input? (hint: you are not testing sensation at the skin here- remember the muscle spindles we saw histologically.)
    - What peripheral nerve will transmit the motor output?

Nerve	*Muscle Group Innervated (motor)*	*Sensory Fibers?*	*Cutaneous Innervation (sensory)*	*Autonomous Zone*
Musculocutaneous n.	Flexors of the elbow joint	Yes	Yes	Medial antebrachium
Axillary n.	Flexors of the shoulder joint	Yes	Yes	Lateral shoulder
Radial n.	Extensors of elbow, carpal and digital joints	Yes	Yes	Lateral antebrachium, dorsal surface of manus
Median n.	Flexors of carpal and digital joints	Yes	Yes	No
Ulnar n.	Flexors of carpal and digital joints	Yes	Yes	Caudal antebrachium; lateral surface 5th digit
Lateral thoracic n.	Cutaneous trunci	Yes	No	No

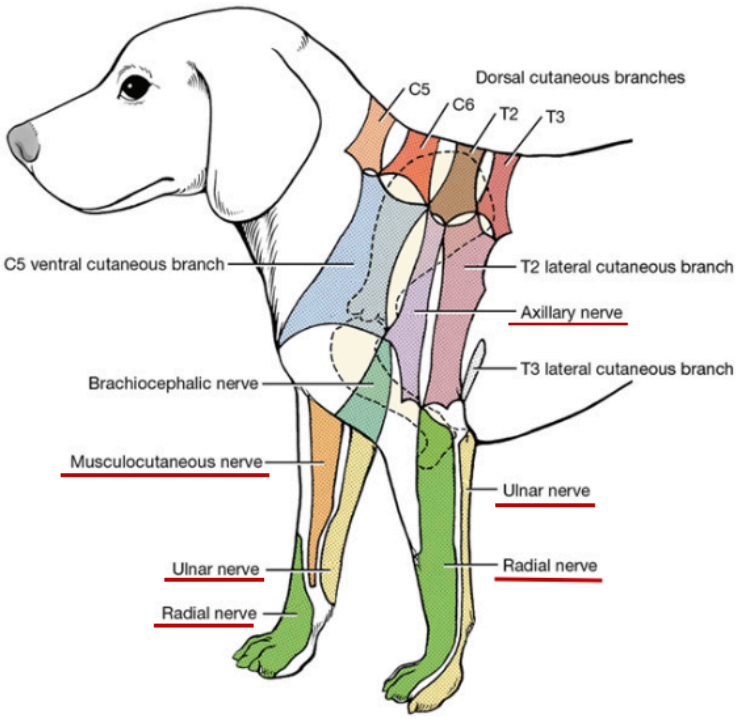

Image source: Figure 3-39, Chapter 3: The Neck, Thorax, and Thoracic Limb, page 146. Guide to the Dissection of the Dog, deLahunta & Evans.

Nerve	*Muscle Group Innervated (motor)*	*Sensory Fibers?*	*Cutaneous Innervation (sensory)*	*Autonomous Zone*
Femoral n.	Flexors of the hip Extensors of the stifle	Yes	Yes Saphenous nerve	Medial side of crus
Obturator n.	Adductors of hindlimb	Yes	No	No
Sciatic n.	Hamstring group	Yes	Yes	Lateral and caudal thigh and crus
Common peroneal n. (Fibular)	Flexors of tarsus Extensors of digits	Yes	Yes	Dorsal surface of pes
Tibial n.	Extensors of tarsus Flexors of digits	Yes	Yes	Plantar surface of pes

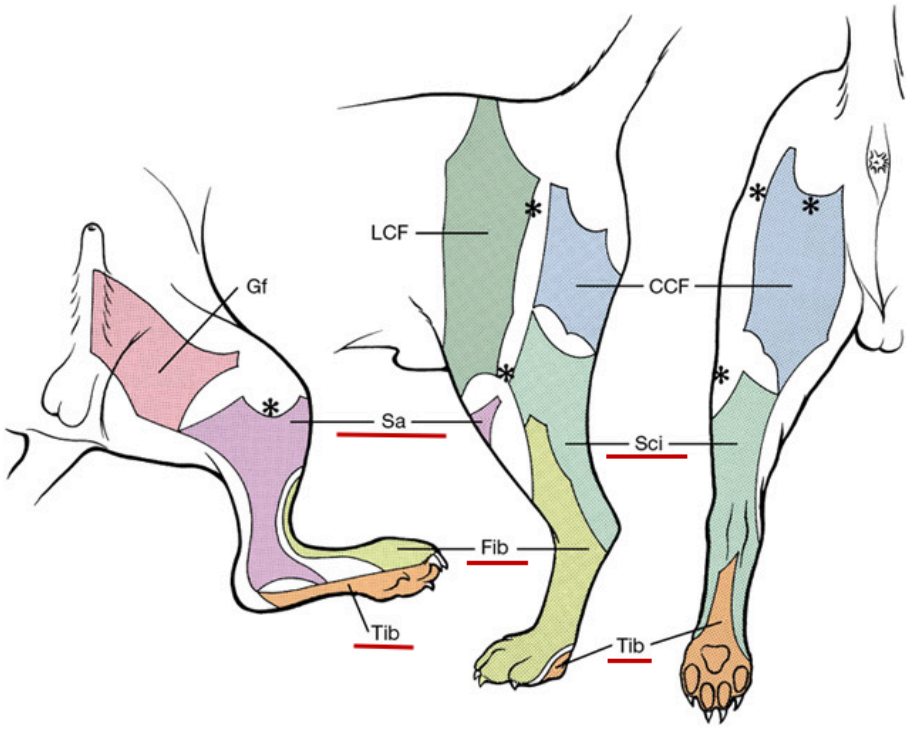

Image source: Figure 4-74, Chapter 4: The Abdomen, Pelvis, and Pelvic Limb, page 217. Guide to the Dissection of the Dog, Eighth Edition, de Lehunta & Evans.
