CNS and Anesthesia

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The Nervous System

- Central (CNS) and Peripheral (PNS)

Central nervous system (CNS)

- Nerves and associated structures within the brain and spinal cord

Brain

- Cerebrum
- Brain stem

Spinal cord

- Gray matter

White matt Brem

CSF

- Formed at choroid plexuses in the ventricles
- Cushioning effect
- Normal: 10 mmHg in pressure, 1.002 – 1.009 in SG, 7.32 in pH
- Increased production, decreased absorption, and/or obstruction of flow of CSF all contribute to hydrocephalus symptom

Peripheral nervous system (PNS)

- The nerves and ganglia which lie outside the brain and spinal cord.
- Cranial nerves and spinal nerves extend from the CNS to peripheral organs such as muscles, joints and glands.
- Nerves are bundles of nerve fibers, much like muscles are bundles of muscle fibers. Ganglia are collections, or small knots, of nerve cell bodies outside the CNS.
- The peripheral nervous system is further subdivided into an afferent (sensory) division and an efferent (motor) division (see figure 2)
- The efferent or motor division is again subdivided into the somatic nervous system and the autonomic nervous system.
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Figure 3. Division of the nervous system

Cranial nerves

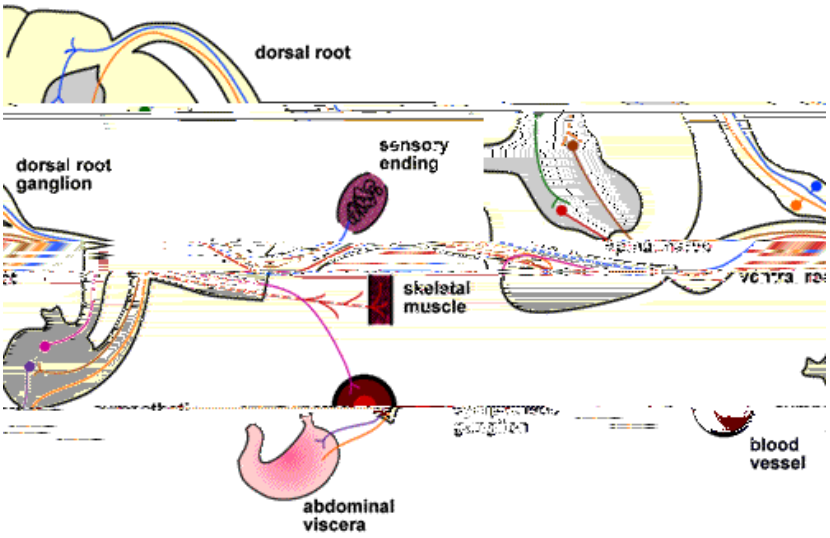
Table 1. Cranial nerves and their function

Nerves in order	Modality	Function
Olfactory (I)	Sensory	Smell
Optic (II)	Sensory	Vision

Spinal nerves

- Begins at foramen magnum and terminates at L6/7 in dogs, at L7/S1 in cats and L6/S1 in horses.
  - Consists of ventral and dorsal roots. (see figure 3)
  - The dorsal root contains sensory neurons while the ventral root contains motor neurons.
  - Consists of white matter which forms ascending and descending pathways and grey matter that contains cell bodies

Figure 3. Components of a spinal nerve



Anatomy and function of the nerve fibers

- A neuron consists of a cell body or soma, dendrites, and a nerve fiber or axon. The axon

Table 3. Peripheral nerve classification on the basis of fiber diameter and velocity of conduction of nerve impulses

fiber	*Anatomic location*	*Myelinated*	*Fiber diameter (µm)*	*Conduction speed (m/sec)*

/ 343.4Tm [(()-j ET EMET EMET>BDC q 66.9Q q 273.6 (()-1(m)-16(/)-6(s)-5(ec))]TJ

Autonomic nervous system

- It is further subdivided into sympathetic and parasympathetic divisions (see figure 3).
- Because the autonomic nervous system regulates involuntary or automatic functions, it is called the involuntary nervous system.

The

The Sympathetic Nervous System (thoracolumbar)

- acetylcholine is transmitter between pre and postganlionic neurons; norepinephrine is neurotransmitter between the neuron and effector cell
- sympathetic stimulation produces more generalized effects than parasympathetic stimulation
- adrenal medulla is

Neurotransmission

- A nerve impulse is an electric current that passes along an axon to the presynaptic membrane. Upon reaching the presynaptic membrane, it causes the release of neurotransmitters into the synaptic cleft.
- The neu

Adrenergic transmission:

- Catecholamines (dopamine,norepinephrine, epinephrine) are the neurotransmitters
- Primary means of terminating action is by neural membrane reuptake of the transmitter, although metabolism by catechol-O-methyltransferase (COMT) and monoamine oxidase (MAO) is important in some tissues.

Adrenergic receptors

- **Alpha receptors** are mainly subdivided into alpha-1 and alpha 2 receptors
- Alpha-1
  - principally found in peripheral vascular smooth muscle
- Alpha-2
  -

Figure 7. Alpha adrenergic receptor

NANC(nonadrenergic& noncholinergic) – NO

- In the brain, spinal cord, and peripheral nervous system.
- L-Arginine and O_2 produce L- Citrulline and NO by NO synthases
- It activates guanyl cyclase to increase cGMP which leads to relaxation of smooth muscle.
- NMDA glutamate receptor activation releases NO and in turn results in excitatory neurotransmission in the CNS.
- NOS inhibitor causes dose-dependent MAC decrease

Neuromuscular junction and neuromuscular blocker (NMB)

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- Choline can reenter nerve terminal to again participate in the synthesis of new acetylcholine
- Depolarizing neuromuscular blocker
  - Succinylcholine (suxamethonium in Europe), mimics the action of Ach by occupying postsynaptic nicotinic cholinergic receptor, thus depolarizing postsynaptic membrane. However, hydrolysis of Sch is slower, so postjunctional membrane does not respond to subsequently released Ach prolonging neuromuscular blockade (Phase I).
  - Side effects include hyperkalemia, hypertension, myalgia, cardiac arrhythmia, and increased intraocular pressure. Also known as a trigger for malignant hyperthermia in susceptible patients.
- Nondepolarising NMBs
  - Some examples of drugs falling into this category are pancuronium, atracurium, doxacurium, vecuronium and mivacurium.
  - These agents bind to the post synaptic nicotinic cholinergic receptors without causing any activation of ion channel permeability, and yet impeding normal postjunctional depolarization with less Ach availability at the receptor leading to the neuromuscular blockade.
  - Occupation as many as 70 % does not produce neuromuscular blockade, but 80 – 90 % occupation fails neuromuscular transmission, indicating wide safety margin of the drug.
- Clinically, a peripheral nerve stimulator is employed to assess the neuromuscular blocking effect induced with the drugs.
- Train of Four, Single Twitch, Tetanic or Double Burst Stimulation are applied to test the degree of neuromuscular transmission.

Theories of Anesthesia

- Wide range of compounds produce anesthesia, without any unifying chemical structure or activity
- We don't as yet understand how general anesthetics function
- A key concept in any theory regarding anesthetic mechanisms must be the ability of the anesthetic to disrupt cellular and intercellular communication, particularly in the CNS.
- Many hypotheses have been proposed over the years; it appears that there is expansion and fluidization of the cell membrane by anesthetic agents that result in depressed synaptic transmission, and some anesthetic agents also hyperpolarize neurons by increasing potassium permeability.
- Meyer-Overton hypothesis asserts that, anesthesia results from the presence of a certain concentration of the anesthetic at a hydrophobic site. Evidence (on Page 16(n)-3-20reas t-6(n)]TJ

- The reticular activating system, a multi-synaptic structure, is believed to be the most important site within the central nervous system for anesthetic action.
- We do have an understanding of how certain classes of drugs work - those that interact with specific receptor sites.
  - opioids (eg, morphine, butorphanol)
  - alpha-2 receptor agonists (eg, xylazine, medetomidine)
  - benzodiazepines (eg, diazepam, midazolam)