

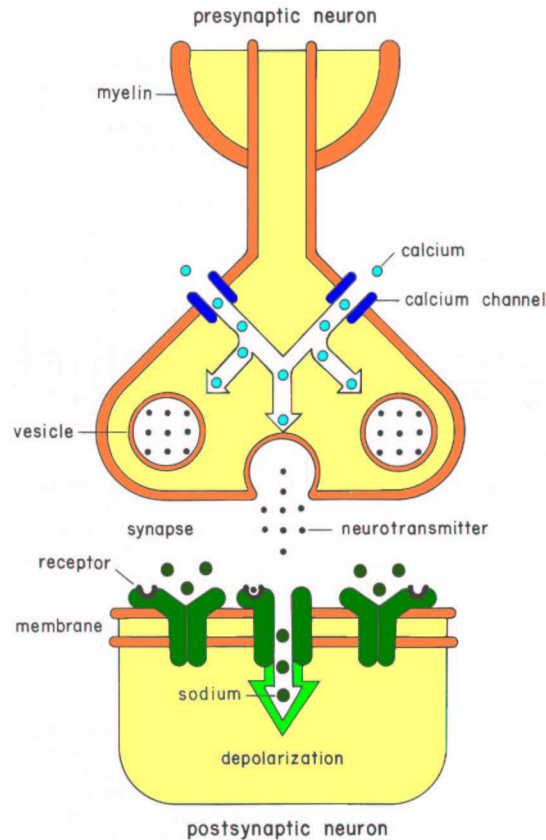
Nervous System
ANS 215
Physiology and Anatomy of
Domesticated Animals

Nerve Transmission

- Action potentials are changes in the resting membrane potential that are actively propagated along the membrane of the cell.
- Application of a stimulus diminishes the membrane potential.
- When membrane potential reaches a critical value lower than resting level an action potential occurs.
- The membrane potential at which an action potential occurs is called the threshold.
- During an action potential, depolarization can change the membrane potential from -70 mV to about $+30$ mV. During repolarization the membrane potential returns to -70 mV.
- The nerve fiber cannot be stimulated again until repolarization is complete. This period is called the refractory period.
- If the stimulus is sufficient to initiate an action potential the entire fiber will fire. This is called the, “all or none principle,” for nerve fibers.

Saltatory Conduction

- In myelinated fibers, the depolarization and repolarization processes are the same, but the action potentials occur from one node of ranvier to the next instead of the entire area of the membrane. This process is called saltatory conduction (saltation refers to the jumping or dancing action of nerve transmission).



Neurotransmitters are required for synapse transmission.

Two such examples associated with the autonomic nervous system are acetylcholine (ACh) and norepinephrine (a.k.a. noradrenaline). Notice that the receptor with a neurotransmitter is the only one open.

Neurotransmitters

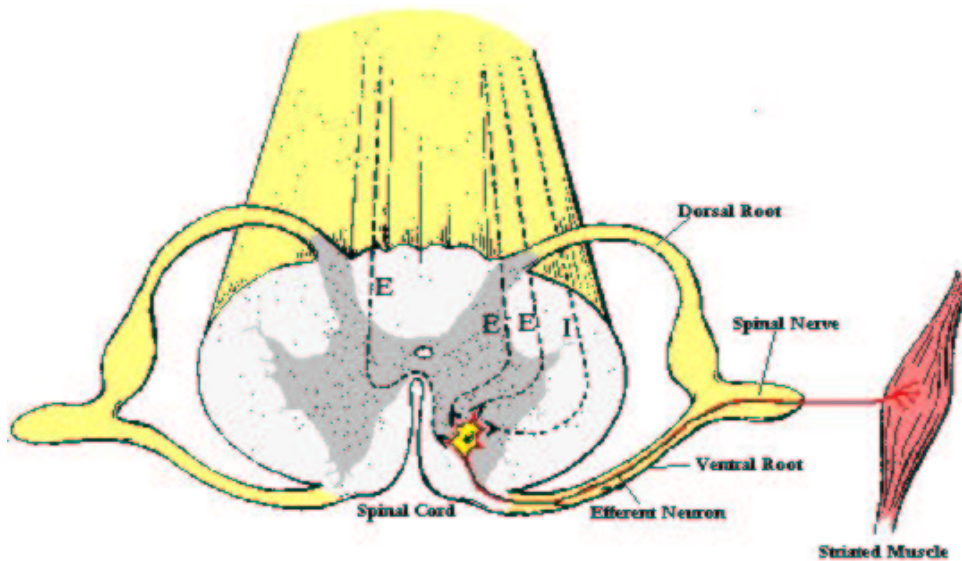
- A nerve impulse causes release of a chemical at the terminal bulb of the synapse.
- The type of chemical released differs according to the fiber type.
- Release of the chemical causes depolarization of the post-synaptic fiber or structure (e.g. muscle).

Peripheral Transmitters

- Neurotransmitters of the peripheral nervous system are excitatory – increase in permeability of affected membrane for sodium ions
- Acetylcholine is the neurotransmitter for cranial, spinal, and parasympathetic divisions of the autonomic nervous system.
- Preganglionic transmitter for the sympathetic division is acetylcholine.
- Postganglionic transmitter for the sympathetic division is norepinephrine.

Central Transmitters

- In the central nervous system there are both excitatory and inhibitory transmitters.
- Inhibitory transmitters decrease the permeability of the affected membrane for sodium.
- Cumulative effect of excitatory and inhibitory transmitters determine if action potential occurs.



Neuron going to striated muscle. This represents the final common pathway. To fire, a greater amount of excitatory neurotransmitter (E) must be released than inhibitory neurotransmitter (I).

Final Common Pathway

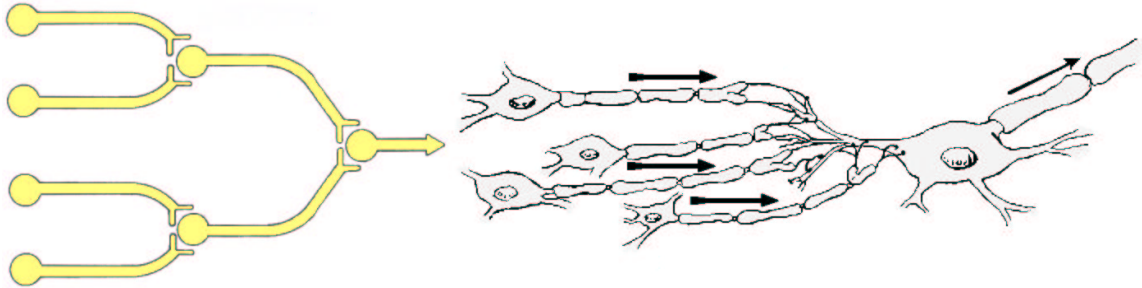
- In the CNS the branches of many axons impinge on a particular neuron.
- If the neuron is the last in a series, it represents the final common pathway.
- Activity of that neuron will result from a cumulative effect of inhibitory and excitatory inputs.

Neuron Placement

- Within the CNS are several schemes of neuron placement (circuits) that allow for different paths of activity.
- These circuits allow for alternative ways of handling, amplifying and focusing information in the CNS

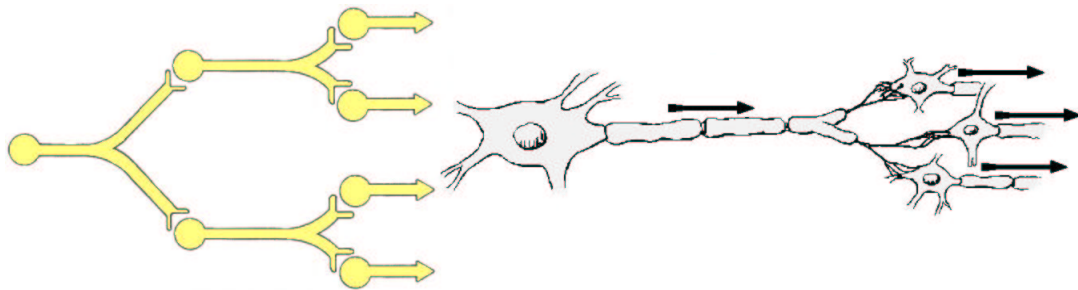
Converging Circuit

Allows impulses from many different sources to cause some response or provide a sensation.



Diverging Circuit

Axon branches of one neuron impinge on two or more neurons, and each of these in turn impinge on two or more neurons.



Reverberating Circuit

Each neuron in a series sends a branch back to the beginning neuron so that a volley of impulses is received at the final neuron.



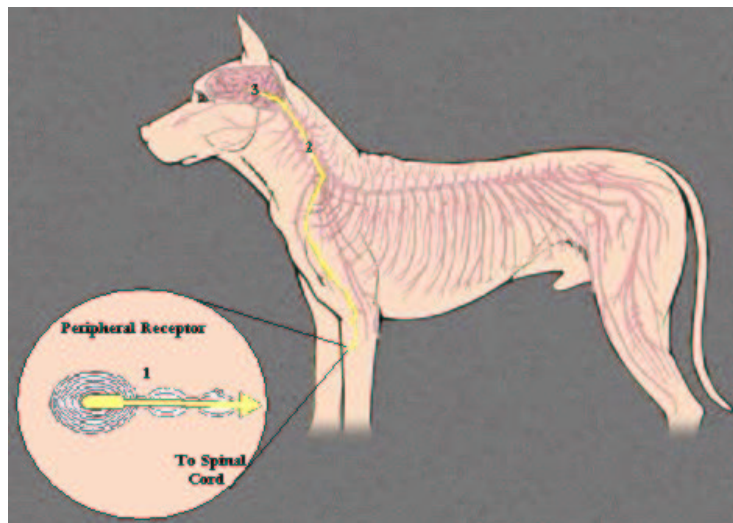
Parallel Circuit

Contains a number of neurons in series, with each neuron supplying a branch to the final neuron.



Reflexes

- A reflex is defined as an automatic or unconscious response of an effector organ (muscle or gland) to an appropriate stimulus.
- Contains a chain of at least two neurons:
 1. an afferent, sensory, or receptor
 2. an efferent, motor, or effector neuron

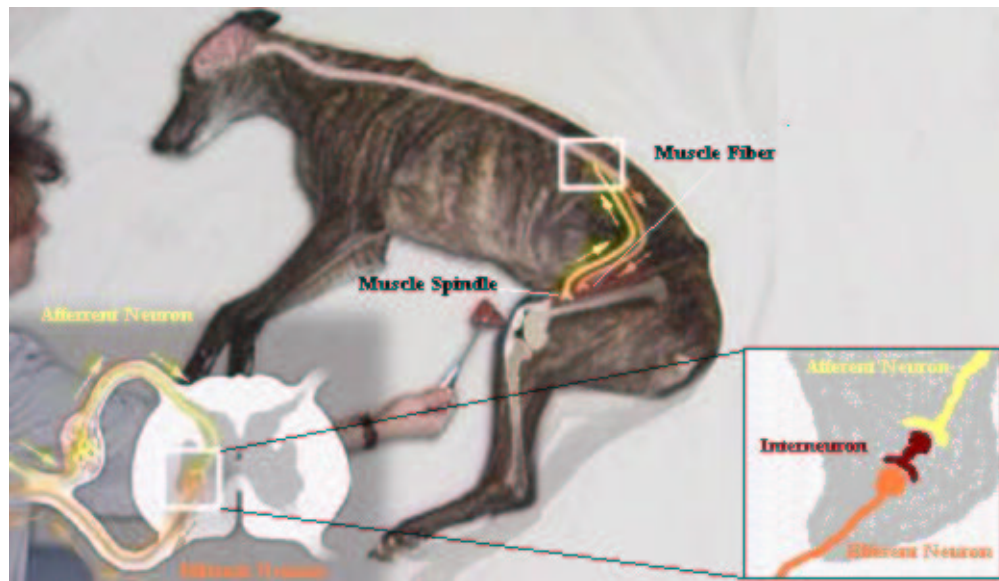


A neuron circuit from periphery to cerebral cortex. A minimum of three neurons is required: 1 – afferent neuron in a mixed spinal nerve, 2 – neuron ascending in a spinal cord tract to the thalamus, 3 – final neuron in the circuit that transmits the impulse to the cerebral cortex.

Spinal Reflex

- Simplest reflex – does not require the brain
- Example is knee jerk reflex elicited by striking patellar ligament.
- Requires an intact and functioning spinal column at that level.
- Reflex is postural in that it aids in standing.

Stretch Reflex



Reflex Centers

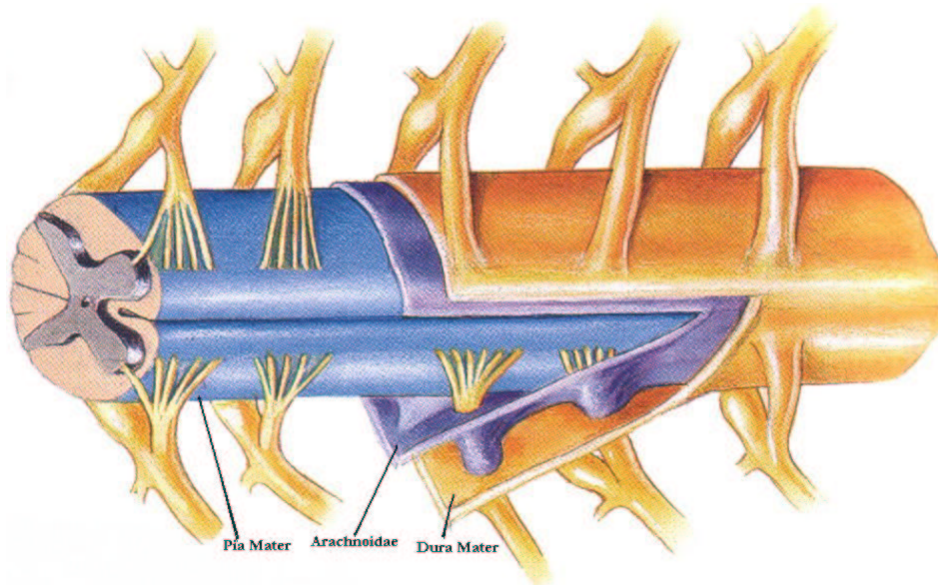
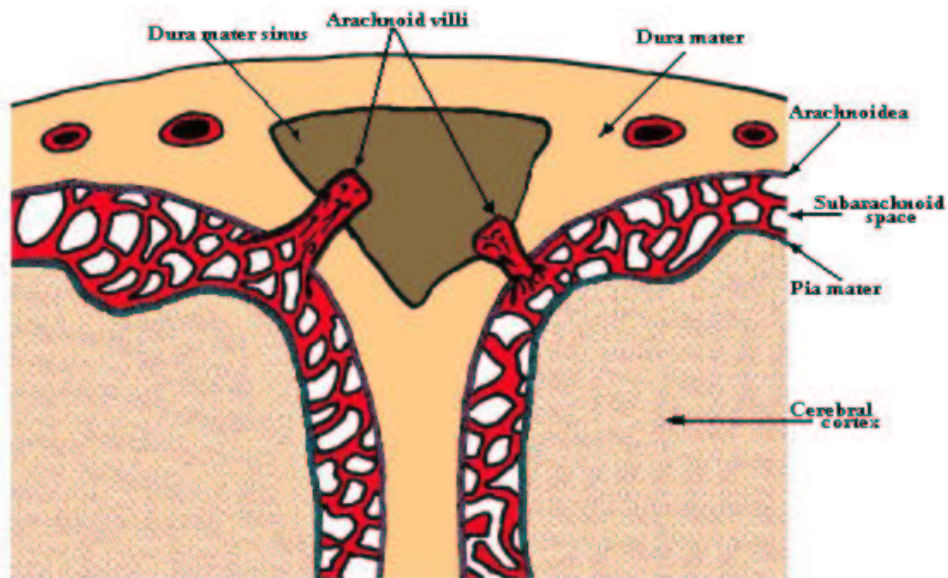
- Located throughout the CNS
- Involved with integration of complex reflexes
- Medulla – heart, respiration, swallowing
- Cerebellum – locomotion, posture
- Hypothalamus – temperature regulation
- Midbrain – visual and auditory reflexes

Postural Reflexes

- Standing – pushing down on back causes muscle response to resist
- Attitudinal – lifting head of horse causes change in stance
- Righting – dropped cat always lands on feet
- Hopping – pushing a supported dog with 3 limbs elevated results in a placement correction of the 4th to act as a pillar

Meninges

- The coverings of the brain and spinal cord.
 1. Dura mater – tough fibrous outer covering
 2. Arachnoidea – the outer layer is practically fused with dura materSubarachnoid space – between arachnoidea and pia, contains cerebrospinal fluid
 3. Pia mater – delicate and most deep of the three layers

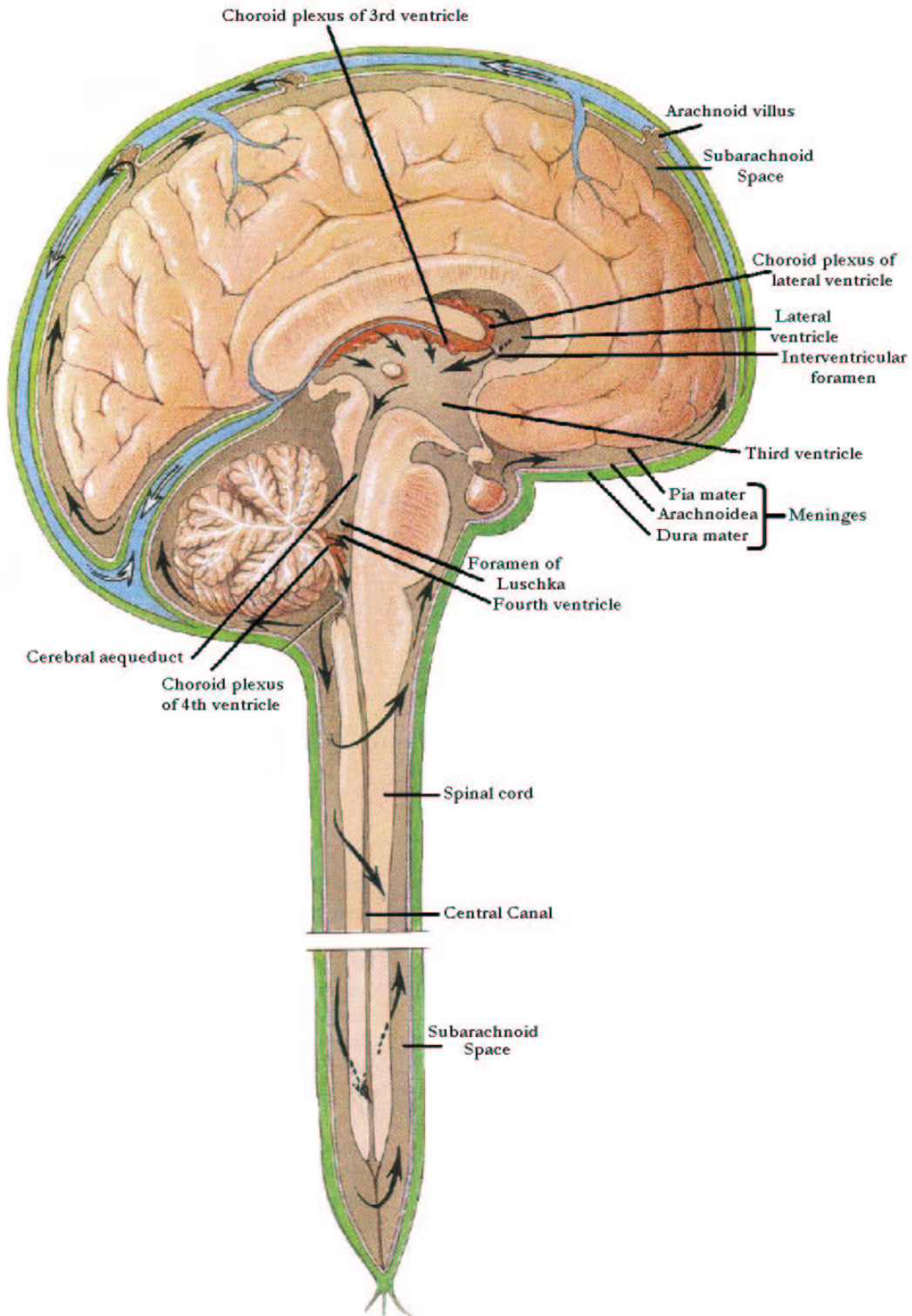


Ventricles of the Brain

- The four ventricles of the brain are cavities within the substance of the brain.
- Lateral ventricles are paired cavities with each right and left cerebral hemisphere.
- The third ventricle is within the interbrain.
- The fourth ventricle is continuous with the third through the cerebral aqueduct and is located beneath the cerebellum and above the medulla.
- The fourth ventricle communicates with the subarachnoid space through the three foramina of Magendie (single) and Luschka (paired).
- The fourth ventricle is continued caudally as the central canal of the spinal cord.
- Each ventricle has a choroid plexus or tuft of capillaries that secretes cerebrospinal fluid.

Cerebrospinal Fluid

- Flows through the cavities of the lateral and third ventricles, through the cerebral aqueduct and fourth ventricle, and finally into the subarachnoid space and spinal cord.
- Cerebrospinal fluid is taken up by the meninges.



The pathway of cerebrospinal fluid flow.

CNS Metabolism

- Energy is principally carbohydrate (glucose)
- Insulin is not required for uptake of glucose
- CNS represents 2% of body mass, but consumes 20% of the oxygen
- Metabolic rate of grey matter is 3 – 4 times higher than that of white matter