Anatomy of the nervous system

ASSIGN BUSTER

Anatomy of the Nervous System Structure of the Vertebrate Nervous System - Neuroanatomy is the anatomy of the nervous system. - Refers to the study of the various parts of the nervous system and their respective function(s). - The nervous system consists of many substructures, each comprised of many neurons. Structure of the Vertebrate Nervous System - Terms used to describe location when referring to the nervous system include: — Ventral: toward the stomach — Dorsal: toward the back — Anterior: toward the front end — Posterior: toward the back end — Lateral: toward the side — Medial: toward the midline Structure of the Vertebrate Nervous System - The Nervous System is comprised of two major subsystems: 1. The Central Nervous System (CNS) 2. The Peripheral Nervous System (PNS) Structure of the Vertebrate Nervous System - The Central Nervous System consists of: 1. Brain 2. Spinal Chord Structure of the Vertebrate Nervous System ï‚§ The spinal cord is the part of the CNS found within the spinal column and communicates with the sense organs and muscles below the level of the head. ï‚§ The Bell-Magendie law states the entering dorsal roots carry sensory information and the exiting ventral roots carry motor information. ï‚§ The cell bodies of the sensory neurons are located in clusters of neurons outside the spinal cord called dorsal root ganglia. Structure of the Vertebrate Nervous System - The spinal cord is comprised of: — grey matter-located in the center of the spinal cord and is densely packed with cell bodies and dendrites — white matter — composed mostly of myelinated axons that carries information from the gray matter to the brain or other areas of the spinal cord. - Each segment sends sensory information to the brain and receives motor commands. Structure of the Vertebrate Nervous System - The Peripheral Nervous System (PNS) is comprised of the: 1. Somatic Nervous

System 2. Autonomic Nervous System Structure of the Vertebrate Nervous System - The Somatic Nervous System consists of nerves that: — Convey sensory information to the CNS. — Transmit messages for motor movement from the CNS to the body. Structure of the Vertebrate Nervous System - The autonomic nervous system sends and receives messages to regulate the automatic behaviours of the body (heart rate, blood pressure, respiration, digestion, etc). - Divided into two subsystems: 1. The Sympathetic Nervous System. 2. The Parasympathetic Nervous System. Structure of the Vertebrate Nervous System - The sympathetic nervous system is a network of nerves that prepares the organs for rigorous activity: — increases heart rate, blood pressure, respiration, etc. (“ fight or flight" response) — comprised of ganglia on the left and right of the spinal cord — mainly uses norepinephrine as a neurotransmitter at the postganglionic synapses. Structure of the Vertebrate Nervous System - The parasympathetic nervous system facilitates vegetative, nonemergency responses. — decreases functions increased by the sympathetic nervous system. — comprised of long preganglion axons extending from the spinal cord and short postganglionic fibers that attach to the organs themselves. — dominant during our relaxed states. Structure of the Vertebrate Nervous System - Parasympathetic Nervous System (cont’d) — Postganglionic axons mostly release acetylcholine as a neurotransmitter Structure of the Vertebrate Nervous System - Three major divisions of the brain include: 1. Hindbrain. 2. Midbrain. 3. Forebrain. Area Forebrain Also Known As Prosencephalon (“ forward-brain") Diencephalon (“ between-brain") Telencephalon (“ end brain") Major Structures Thalamus, Hypothalamus Cerebral cortex, hippocampus, basal ganglia Tectum, tegmentum, superior colliculus, inferior

colliculus, substantia nigra Midbrain Mesencephalon (“ middlebrain") Hindbrain Rhombencephalon (“ parallelogram-brain") Metencephalon (“ afterbrain") Myencephalon (“ marrowbrain") Structure of the Vertebrate Nervous System - The Hindbrain consists of the: — Medulla. — Pons. — Cerebellum. - Located at the posterior portion of the brain - Hindbrain structures, the midbrain and other central structures of the brain combine and make up the brain stem. Structure of the Vertebrate Nervous System - The medulla: — Located just above the spinal cord and could be regarded as an enlarged extension of the spinal cord. — responsible for vital reflexes such as breathing, heart rate, vomiting, salivation, coughing and sneezing. - Cranial nerves allow the medulla to control sensations from the head, muscle movements in the head, and many parasympathetic outputs to the organs. Structure of the Vertebrate Nervous System - Pons — lies on each side of the medulla (ventral and anterior). — along with the medulla, contains the reticular formation and raphe system. — works in conjunction to increase arousal and readiness of other parts of the brain. Structure of the Vertebrate Nervous System - The reticular formation: — descending portion is one of several brain areas that control the motor areas of the spinal cord. — ascending portion sends output to much of the cerebral cortex, selectively increasing arousal and attention. - The raphe system also sends axons to much of the forebrain, modifying the brain’s readiness to respond to stimuli. Structure of the Vertebrate Nervous System - The Cerebellum: — a structure located in the hindbrain with many deep folds. — helps regulate motor movement, balance and coordination. — is also important for shifting attention between auditory and visual stimuli. Structure of the Vertebrate Nervous System - The midbrain is comprised of the following structures: —

Tectum — roof of the midbrain — Superior colliculus & inferior colliculus— located on each side of the tectum and processes sensory information — Tegmentum- the intermediate level of the midbrain containing nuclei for cranial nerves and part of the reticular formation — Substantia nigra - gives rise to the dopaminecontaining pathway facilitating readiness for movement Structure of the Vertebrate Nervous System - The forebrain is the most anterior and prominent part of the mammalian brain and consists of two cerebral hemispheres — Consists of the outer cortex and subcortical regions. — outer portion is known as the “ cerebral cortex". — Each side receives sensory information and controls motor movement from the opposite (contralateral) side of the body. Structure of the Vertebrate Nervous System - Subcortical regions are structures of the brain that lie underneath the cortex. - Subcortical structures of the forebrain include: — Thalamus - relay station from the sensory organs and main source of input to the cortex. — Basal Ganglia - important for certain aspects of movement. Structure of the Vertebrate Nervous System - The limbic system consists of a number of other interlinked structures that form a border around the brainstem. — Includes the olfactory bulb, hypothalamus, hippocampus, amygdala, and cingulate gyrus of the cerebral cortex — associated with motivation, emotion, drives and aggression. Structure of the Vertebrate Nervous System - Hypothalamus — Small area near the base of the brain. — Conveys messages to the pituitary gland to alter the release of hormones. — Associated with behaviours such as eating, drinking, sexual behaviour and other motivated behaviours. - Thalamus and the hypothalamus together form the “ diencephalon". Structure of the Vertebrate Nervous System - Pituitary gland - hormone producing gland found at the base of the

hypothalamus. - Basal Ganglia - comprised of the caudate nucleus, the putamen, and the globus pallidus. — Associated with planning of motor movement, and aspects of memory and emotional expression . Structure of the Vertebrate Nervous System - Basal forebrain is comprised of several structures that lie on the ventral surface of the forebrain. - Contains the nucleus basalis: — receives input from the hypothalamus and basal ganglia — sends axons that release acetylcholine to the cerebral cortex — Key part of the brains system for arousal, wakefulness, and attention Structure of the Vertebrate Nervous System - Hippocampus is a large structure located between the thalamus and cerebral cortex. — Toward the posterior portion of the forebrain — critical for storing certain types of memory. Structure of the Vertebrate Nervous System - The central canal is a fluid-filled channel in the center of the spinal cord. - The ventricles are four fluid-filled cavities within the brain containing cerebrospinal fluid. - Cerebrospinal fluid is a clear fluid found in the brain and spinal cord: — Provides “ cushioning" for the brain. — Reservoir of hormones and nutrition for the brain and spinal cord. - Meninges are membranes that surround the brain and spinal cord The Cerebral Cortex - The cerebral cortex is the most prominent part of the mammalian brain and consists of the cellular layers on the outer surface of the cerebral hemispheres. — divided into two halves — joined by two bundles of axons called the corpus callosum and the anterior commissure. — more highly developed in humans than other species. The Cerebral Cortex - Organization of the Cerebral Cortex: — Contains up to six distinct laminae (layers) that are parallel to the surface of the cortex. — Cells of the cortex are also divided into columns that lie perpendicular to the laminae. — Divided into four lobes: occipital, parietal, temporal, and frontal. The

Cerebral Cortex - The four lobes of the cerebral cortex include the following: Occipital lobe Parietal lobe Temporal lobe Frontal lobe 1. 2. 3. 4. The Cerebral Cortex - Occipital lobe: — Located at the posterior end of the cortex. — Known as the striate cortex or the primary visual cortex. — Highly responsible for visual input. — Damage can result in cortical blindness. The Cerebral Cortex - Parietal lobe — Contains the postcentral gyrus (aka “ primary somatosensory cortex") which is the primary target for touch sensations, and information from muscle-stretch receptors and joint receptors. — Also responsible for processing and integrating information about eye, head and body positions from information sent from muscles and joints. The Cerebral Cortex - Temporal Lobe — Located on the lateral portion of each hemisphere near the temples. — Target for auditory information and essential for processing spoken language. — Also responsible for complex aspects of vision including movement and some emotional and motivational behaviours. — KlÃ¼ver-Bucy syndrome associated with temporal lobe damage The Cerebral Cortex - The Frontal lobe: — Contains the prefrontal cortex and the precentral gyrus. — Precentral gyrus is also known as the primary motor cortex and is responsible for the control of fine motor movement. — Contains the prefrontal cortex- the integration center for all sensory information and other areas of the cortex. (most anterior portion of the frontal lobe) The Cerebral Cortex - The Prefrontal cortex (cont’d) — responsible for higher functions such as abstract thinking and planning. — responsible for our ability to remember recent events and information (“ working memory"). — allows for regulation of impulsive behaviours and the control of more complex behaviours. The Cerebral Cortex - Various parts of the cerebral cortex do not work independently of each other. — All areas of

the brain communicate with each other, but no single central processor exists that puts it all together - The binding problem refers to how the visual, auditory, and other areas of the brain produce a perception of a single object. — perhaps the brain binds activity in different areas when they produce synchronous waves of activity Research Methods - Main categories of research methods to study the brain include those that attempt to: 1. Correlate brain anatomy with behaviour. 2. Record brain activity during behaviour. 3. Examine the effects of brain damage. 4. Examine the effects of stimulating particular parts of the brain. Research Methods - The process of relating skull anatomy to behaviour is known as phrenology. — One of the first ways used to study the brain. — Yielded few, if any accurate results Research Methods - Correlating brain activity with behaviour can involve the identifying of peculiar behaviours and looking for abnormal brain structures or function. - These abnormal brain structures can be identified using: — Computerized Axial Tomography (CAT scan). — Magnetic Resonance Imaging (MRI). Research Methods - Computerized Axial Tomography (CAT scan) involves the injection of a dye into the blood and a passage of x-rays through the head. — Scanner is rotated slowly until a measurement has been taken at each angle and a computer constructs the image - Magnetic Resonance Imaging (MRI) involves the application of a powerful magnetic field to image the brain. Research Methods - Recording brain activity involves using a variety of noninvasive methods including: — Electroencephalograph (EEG) - records electrical activity produced by various brain regions. — Positron-emission tomography (PET) records emission of radioactivity from injected radioactive chemicals to produce a high- resolution image. Research Methods - Regional Cerebral Blood Flow (rCBF) — inert radioactive chemicals

are dissolved in the blood where a PET scanner is used to trace their distribution and indicate high levels of brain activity. - Functional Magnetic Resonance Imaging uses oxygen consumption in the brain to provide a moving and detailed picture. Research Methods - Examining the effects of damage to the brain is done using laboratory animals and includes: — Lesion techniques: purposely damaging parts of the brain. — Ablation techniques: removal of specific parts of the brain. - Researchers use a stereotaxic instrument to damage structure in the interior of the brain Research Methods - Other research methods used to inhibit particular brain structures include: — Gene-knockout approach: use of various biochemicals to inactivate parts of the brain by causing gene mutations critical to their development or functioning. — Transcranial magnetic stimulation: the application of intense magnetic fields to temporarily inactivate neurons. Research Methods - Brain Stimulation techniques assume stimulation of certain areas should increase activity. — Researchers observe the corresponding change in behaviour as a particular region is stimulated. — Example: transcranial magnetic stimulation — Limitation is that many interconnected structures are responsible for certain behaviours Research Methods - Research has not supported that a larger brain is correlated with higher intelligence. - Brain-to-body ratio research has some limited validity. - Moderate correlation exists between IQ and brain size (. 3) - Amount of grey and white matter may also play a role. - IQ is correlated with amount of grey matter. Research Methods - Greater resemblance among twins for both brain size and IQ. - For monozygotic twins, the size of one twin’s brain correlates significantly with the other twin’s IQ. - Therefore, whatever genes that control brain also relate to IQ. Research Methods - Men have larger brains than women but IQ is the same. -

Various differences in specific brain structures exist between men and women — Left/right cortex, hippocampus and amygdala - Explanations in differences in cognitive abilities can perhaps be better explained by interest than abilities.