Neuron structure answer key pdf

Neurons have four specialized structures that enable the transmission and reception of information: cell body (soma), dendrites, axon and axon terminals (see lowest digit). Cell Body or Soma: The cell body is the part of the cell that surrounds the nucleus and plays a major role in synthesizing proteins. Dendrites: The dendrites are short, branching processes that extend from the cell body. Dendrites work to receive information, and do so through numerous receptors located in their membranes that bind to chemicals, called neurotransmitters. Axon: An axon is a large process that extends from the cell body at a point of origin—called axon hillock—and functions for sending information. In contrast to the shorter dendrites, axon can last for more than one meter. Because of this length, the axon contains microtubules and is surrounded by myelin. Microtubules are arranged inside axon as parallel arrays of long strands that act as highways for the movement of materials to and from soma. Specialized motor proteins walk along microtubules, carrying material away from soma (anterograde transport) or back to soma (retrograde transport). This system can move materials down axodan with prices of 400mm/day (see lowest figure). Myelin consists of completely separate cells such as coil and wrap their membranes around the outside of the axon. These are essential for electrical insulation and for accelerating action potential propagation. Image produced by BYU-Idaho Student Jared Cardinet 2013 Picture shows Anterograde and Retrograd transport in an axon. Axon Terminals: When an axon reaches a target, it ends in several endings, called axon terminals. The axon terminal is designed to convert the electrical signal into a chemical signal in a process called synaptic transmission (further explained in the neuron physiology section). Most neurons are amitotic or lose their ability to divide. Exceptions to this rule exist in odor neurons (those associated with odor) and hippocampus regions of the brain. Fortunately, the life span of amitotic neurons is close to 100 years. Still, if a neuron is damaged or lost, it's not easily replaced. For this reason, there is usually limited recovery from severe brain or spinal cord injuries. Perhaps the slow rate of recovery or lack of renewal is to ensure that learned behavior and memories are preserved throughout life. Neurons also have exceptionally high metabolism and subsequently require high levels of glucose and oxygen. The body will go to large lengths to ensure that neurons are adequately fed; In fact, if for some reason the brain detects that it does not receive adequate amounts of nutrition, the body will shut down immediately (i.e. faint). Title: Neuron-figur-notext.svg; Author: Nicolas.Rougier; Place: License: License: the file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license. Illustration of important neuronal structures Structural classification of neurons is based on the number of processes extending out of the cell body. Three large groups arise from this classification: multipolar, bipolar, and unipolar neurons. Multipolar neurons are defined as having three or more processes extending out of the cell body. They consist of more than 99% of the neurons in humans, and are the main neuron type found in the CNS and efferent division of PNS. Title: Neurons uni bi multi pseudouni.svg; Author: Pseudounipolar_bipolar_neurons.svg: Juoj8 derivative work: Jonathan Haas; Location: Neurons_uni_bi_multi_pseudouni.svg; License: This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license. Structural classification of neurons. 1) Bipolar; 2) Multipolar and 3) Unipolar. Bipolar neurons have only two processes that extend in opposite directions from the cell body. One process is called a dendrite, and another process is called the axon. Although rare, these are found in the retina of the eye and olfactory system. Unipolar neurons have a single, short process that extends from the cell body and then branches into two additional processes that extend in opposite directions. The process that extends peripherally is called the peripheral process and is associated with sensory reception. The process that extends towards the CNS is the central process. Unipolar neurons are found mainly in the afferent division of PNS. Functional classification of neurons Neurons Neurons are classified functionally according to the direction in which the signal travels, in relation to the CNS. This classification also results in three different types of neurons: sensory neurons, motor neurons, and internal neurons. Sensory neurons, or afferent neurons transmit information from sensory receptors in the skin, or the internal organs against the CNS for processing. Almost all sensory neurons are unipolar. Motor, or efferent neurons transfer information away from the CNS against any type of effector. Motor neurons are usually multipolar. Interneurons are located between motor and sensory pathways and are very engaged in signal integration. The vast majority of internal eurons are limited within the CNS. **You may use the buttons below to go to the next or previous reading in this Module ** Neurons are specialized cells that transmit chemical and electrical signals to facilitate communication between the brain and the body. Detail structures and functions for each type of neuron Key Takeaways Key Points Neurons are specialized cells that transmit chemical and electrical signals into the brain; they are the basic building blocks of the central nervous system. The componentrna i neurons the soma (cell body), the axon (a long slender projection that directs electrical impulses away from the cell body), dendrites (tree-like structures that receive messages from other neurons), and synapses (specialized cross-neurons). Some axons are covered with myelin, a fat material that acts as an insulator and leaders to speed up the process of communication. Sensory neurons are neurons responsible for transforming external stimuli from the environment into corresponding internal stimuli. Motor neurons are neurons located in the central nervous system (CNS); they project their axons outside the CNS to directly or indirectly control muscles. Interneurons act as intermediaries between sensory and motor neurons, which convert external stimuli into internal stimuli and control muscle movements, respectively. Glial Cell Keytermes: Non-neuronal cells that provide structure and support to neurons. synapse: The junction between the terminal of a neuron and either another neuron or a muscle or glandcell, over which nerve impulses pass. myelin: A white, fatty material consisting of lipids and lipoproteins that surround the axons of the nerves and facilitate rapid communication. Nodes of Ranvier: Periodic gaps in the myelin skin where the signal is uploaded as it moves along the axon. Neuronis the basic building block of the brain and central nervous system. Neurons are specialized cells that transmit chemical and electrical signals. The brain consists entirely of neurons and glial cells, which are non-neuronal cells that provide structure and support for neurons. Nearly 86 billion neurons work together in the nervous system to communicate with the rest of the body. They are responsible for everything from consciousness and thought to pain and hunger. There are three primary types of neurons: sensory neurons, motor neurons, and interneurons. Structures of a neuron In addition to having all normal components of a cell (nucleus, organelles, etc.) neurons also contain unique structures for receiving and sending the electrical signals that make neuronal communication possible. Structure of a neuron: The above image shows the basic structural components of an average neuron, including dendrite, cell body, nucleus, node of ranvier, myelin sheater, schwann cell, and axon terminal. Dendrite Dendrites are branch-like structures that extend away from the cell body, and their job is to receive messages from other neurons and allow these messages to travel to the cell body. Although some neurons do not have any dendrites, other types of neurons have multiple dendrites. Dendrites may have small protrusions called dendritic spines, which further increase the surface area of any connections with other neurons. CellBody Like other cells, each neuron has a cell body (or soma) that contains a nucleus, smooth and reticulum, Golgi apparatus, mitochondria, and other cellular components. Axon An axon, at its most basic, is a tube-like structure that carries an electrical impulse from the cell body (or from another cell's dendrites) to the structures at the opposite end of neuron-axon terminals, which can then pass the impulse to another neuron. The cell body contains a specialized structure, axon hillock, which acts as a cross between the cell body and the axon. Synapse Synapse is the chemical junction between the axon terminals of one neuron and the dendrites of the next. It is a gap where specialized chemical interactions can occur, rather than an actual structure. Function of a Neuron The specialized structure and organization of neurons allows them to transmit signals in the form of electrical impulses from the brain to the body and back. Individually, neurons can pass a signal all the way from their own dendrites to their own axon terminals; But at a higher level neurons are organized into long chains, allowing them to pass signals very quickly from one to the other. A neuron's axon will connect chemically to another neuron dendrite at the synapse between them. Electrically charged chemicals flow from the axona of the first neuron to the dendrite of the second neuron, and that signal will then flow from the dendrite of the second neuron, down its axons, over a synapse, to a third neuron's dendrite, and so on. This is the basic chain of neural signal transmission, which is how the brain sends signals to the muscles to get them to move, and how sensory organs send signals to the brain. It is important that these signals can happen quickly, and they do. Think about how quickly you drop a hot potato-before you even realize it's hot. This is because the feeling bodies (in this case, the skin) sends the signal This is hot! neurons with very long axons that travel up the spine to the brain. If this didn't happen quickly, people would burn themselves. Other structures dendrites, cell bodies, axons, and synapses are the basic parts of a neuron, but other important structures and materials surround neurons to make them more effective. Myelin Sheath Some axons are covered with myelin, a fat material that wraps around the axon to form the myelene shawl. This external coating acts as insulation to minimize dissipation of the electrical signal as it travels down the axon. Myelin's presence on the axon greatly increases the speed of the conduction of the electrical signal, as the grease prevents all electricity from leaking out. This isolation is important, as the axon from a human motor neuron can last as long as a meter-from the base of the spine to the toes. Periodic gaps in myelin skin are called nodes of Ranvier. At these nodes, the signal is charged as it travels along the axon. Cell Myelin skin is not part of the neuron. Myelin is produced by glial cells (or simply glial, or glue in Greek), which are non-neuronal cells that provide support for the nervous system. Glia function to keep neurons in place (hence their Greek name), provide them with nutrients, provide isolation, and remove pathogens and kill neurons. In the central nervous system, the glial cells that form the myelin skin are called the oligodendrocytes; in the peripheral nervous system, they are called Schwann cells. Neurons of the central nervous system: This neuron diagram also shows oligodendrocyte, myelin swarms, and nodes of Ranvier. Types of neurons There are three major types of neurons: sensory neurons, motor neurons, and interneurons. All three have different functions, but the brain needs them all to communicate effectively with the rest of the body (and vice versa). Sensory neurons Sensory neurons are neurons responsible for transforming external stimuli from the environment into corresponding internal stimuli. They are activated by sensory input, and send projections to other parts of the nervous system, ultimately conveying sensory information to the brain or spinal cord. Unlike the motor neurons of the central nervous system (CNS), whose inputs come from other neurons, sensory neurons are activated by physical modalities (such as visible light, sound, heat, physical contact, etc.) or by chemical signals (such as smell and taste). Most sensory neurons are pseudounipolar, meaning they have an axon that branches into two extensions—one connected to dendrites that receive sensory information and another that transmits this information to the spinal cord. Multipolar and pseudounipolar neurons: This diagram shows the difference between: 1) a unipolar neuron; 2) a bipolar neuron; 3) a multipolar neuron; 4) a pseudounipolar neuron. Motor Neurons Motor Neurons are neurons located in the central nervous system, and they project their axons outside the CNS to directly or indirectly control muscles. The interface between a motor neuron and muscle fiber is a specialized synapse called the neuromuscular junction. The structure of motor neurons is multipolar, meaning that each cell contains a single axon and multiple dendrites. This is the most common type of neuron. Interneurons Interneurons are neither sensory nor motor; rather, they act as intermediaries that form relationships between the other two types. Located in the CNS, they work locally, meaning that their axons connect only with nearby sensory or motor neurons. Interneurons can save time and therefore prevent injury by sending messages to the spinal cord and back instead of all the way to the brain. Like motor neurons, they are multipolar in structure. Neural impulses occur when a stimulus depolarizes a cell membrane, prompting a that sends an all or no signal. Outline the steps steps the process of communication between neurons Key Takeaways Key Points The neurons (or excitable neurons) in the nervous system conduct electrical impulses, or signals, that act as communication between sensory receptors, muscles and glands, and the brain and spinal cord. An action potential occurs when an electrical signal interferes with the initial balance of Na^+ and K^+ within a cell membrane, briefly depolarizing the concentrations of each. An electrical impulse travels along the axogen via depolarized voltage gate ion channels in the membrane, and can either jump along a myeline area or travel continuously along an unaweed area. While an action potential is generated by a cell, no other action potential can be generated until the cell's channels return to their resting state. Action potentials generated by neural impulses are all or nothing, meaning that the signal reaches the threshold of communication or it doesn't. No signal is stronger or weaker than another. Key Terms Polarity: The spatial differences in the shape, structure and function of cells. Almost all cell types exhibit some kind of polarity, which allows them to perform specialized functions. Action Potential: A short-term change in the electrical potential that travels along a cell, such as a nerve or muscle fiber, and allows nerves to communicate. Neural Impulse: The signal transmitted along a nerve fiber, either in response to a stimulus (such as touch, pain, or heat), or as an instruction from the brain (such as causing a muscle to contract). resting potential: The almost latent membrane potential of inactive cells. The central nervous system (CNS) goes through a three-stage process when it works: sensory input, neural processing and motor output. The sensory input stage is when neurons (or excitable neurons) of the sensory organs are excited electrically. Neural impulses from sensory receptors are sent to the brain and spinal cord for processing. After the brain has processed the information, neural impulses are then carried out from the brain and spinal cord to the muscles and glands, which is the resulting motor production. A neuron affects other neurons by releasing a neurotransmitter that binds to chemical receptors. The effect on the postsynaptic (receiving) neuron is determined not by the presynaptic (transmitting) neuron or by the neurotransmitter itself, but by the type of receptor that is activated. A neurotransmitter can be seen as a key, and a receptor like a lock: the key unlocks a particular response in the postynaptic neuron, communicating a particular signal. However, in order for a presynaptic neuron to release a neurotransmitter to the next neuron in the chain, it must go through a series of changes in electrical potential. Stages of neural impulses Resting potential is the name of the electrical condition when neuron is not is is signalled. A neuron at dormant potential has a membrane with established amounts of sodium (Na^+) and potassium (K^+) ions on either side, leaving the inside of the neuron negatively charged relative to the outside. The action potential is a rapid change in polarity that moves along nerve fiber from neuron to neuron. In order for a neuron to go from resting potential to action potential—a short-term electrical change that allows an electrical signal to be transmitted from one neuron to another—neurons must be stimulated by pressure, electricity, chemicals, or another form of stimuli. The level of stimulation that a neuron must get to reach action potential is called the threshold of excitation, and until it reaches this threshold, nothing will happen. Different neurons are sensitive to different stimuli, although most can record pain. The potential for action has several steps. Depolarization: A stimulus starts the depolarization of the membrane. Depolarization, also called surge,is caused when positively charged sodium ions rush into a nerve cell. When these positive ions rush in, the membrane in the stimulated cell turns its polarity so that the outside of the membrane is negative relative to the inside. Repolarization. Once the electric gradient has reached the threshold of voltage, the downswing of repolarization begins. The channels allow the positive sodium ion channels through the near level, while channels that allow positive potassium ions are opened, resulting in the release of positively charged potassium ions from the neuron. This expulsion acts to restore the localized negative membrane potential in the cell, bringing it back to its normal voltage. Refract phase. The refractory phase occurs over a short period of time after the depolarization stage. Shortly after the sodium gates open, they close and enter an inactive conformation. The sodium ports cannot be reopened until the membrane is repolarized to its normal resting potential. The sodium potassium pump returns sodium ions to the outside and potassium ions to the inside. During the refractory phase this particular area of the nerve cell membrane can not be depolarized. Therefore, the neuron cannot reach action potential during this rest period. Action potentials: A neuron must reach a certain threshold to begin depolarization steps to reach the action potential. This process of depolarization, repolarization, and recovery moves along a nerve fiber from neuron to neuron like a very fast wave. While one action potential is in progress, another cannot be generated under the same conditions. In unmyelinated axons (axons not covered by a myelin sugar), this happens in a continuous way because there are tension-gated channels throughout the membrane. In myelined axons (axons covered by a myelin this process is described as saltatory because voltage gate channels are only available at the nodes of Ranvier, and the electrical events seem to jump from one node to the next. Saltatory conduction is faster than continuous management. The diameter of Axos also makes a difference, since ions that spread in the cell have less resistance in a larger space. Damage to myelin skin from disease can cause severe impairment of nerve cell function. In addition, some toxins and drugs interfere with nerve impulses by blocking sodium channels in nerves. The all-or-none Signals Amplitude for an action potential is independent of the amount of power that produced it. In other words, larger currents do not create greater action potentials. Therefore, action potentials are said to be all-or-no signals, because either they occur completely or they don't occur at all. The frequency of action potentials is correlated with the intensity of a stimulus. This is in contrast to receptor potentials, whose amplitudes depend on the intensity of a stimulus. Reuptake Reuptake refers to the reabsorption of a neurotransmitter by a presynaptic (send) neuron after it has performed its function of transmitting a neural impulse. Reuptake is necessary for normal synaptic physiology because it allows the recovery of neurotransmitters and regulates the neurotransmitter level in the synapse, thereby checking how long a signal resulting from the neurotransmitter release lasts. Synapse is the place where a chemical or electrical exchange occurs between the presynaptic and postsynaptic cells. Summarize the importance of the synapse to the neurotransmitter communication Key Takeaways Key Points Receptors are pores that allow chemical or electrical signals in the postsynaptic cell. There are two main types of receptor: ligand-gated ion channels, which receive neurotransmitters, and g-protein coupled receptors, which do not. There are two types of possible reactions at the synapse: a chemical reaction or an electrical reaction. During a chemical reaction, neurotransmitters trigger the opening of ligand-gated ion channels on the membrane of the postynaptic cell, resulting in a modification of the cell's internal chemical composition and, in some cases, physical structure. In an electrical reaction, the electrical charge of one cell is affected by another. Although electrical synapses produce faster reactions, chemical synapses result in stronger, more complex changes in the postsynaptic cell. Key Terms vesicle: A membrane-bound tray found in a cell. Action Potential: A short-term change in the electrical potential that travels along a cell, such as a nerve or muscle fiber, and allows nerves to communicate. depolarization: The act of depriving polarity, or the result of such action; reduction to an unpolar state. membrane potential: The voltage membrane, with the inside relative to the outside. Synapse is the junction where neurons trade information. It is not a physical component of a cell, but rather a name for the gap between two cells: the presynaptic cell (which gives the signal) and the postsynnaptic cell (which receives the signal). There are two types of possible reactions at the synapse—chemical or electrical. During a chemical reaction, a chemical called a neurotransmitter is released from one cell to another. In an electrical reaction, the electrical charge of a cell is affected by the charge of an adjacent cell. The electrical response of a neuron to multiple synaptic inputs: Synaptic responses summate in order to bring the postsynaptic neuron to the threshold of excitation, so it can fire an action potential (represented by the top of the chart). All synapses have a few common characteristics: Presynaptic cell: a specialized area within the axon of the giving cell that transmits information to the dendrite in the receiving cell. Synaptic gap: the small space at the synapse that receives neurotransmitters. G-protein linked receptors: receptors that detect molecules outside the cell and thereby activate signals within it. Ligand-gated ion channels: receptors that open or close in response to the binding of a chemical messenger. Postsynaptic cell: a specialized field within the dendrite of dendrite of the receiving cell containing receptors that are designed to process neurotransmitters. The electrical synapse Stages of an electrical reaction at a synapse are as follows: Resting potential. The membrane of a neuron is normally at rest with established concentrations of sodium ions (Na^+) and potassium ions (K^+) on either side. The membrane potential (or, tension over the membrane) at this state is -70 mV, with the inside being negative relative to the outside. Depolarization. A stimulus begins the depolarization of the membrane. Depolarization, also called surge, occurs when positively charged sodium ions (Na^+) suddenly rush through open sodium gates into a nerve cell. If the membrane potential reaches -55 mV, it has reached the threshold for excitation. Additional sodium rushes in, and the membrane of the stimulated cell actually turns its polarity so that the outside of the membrane is negative relative to the inside. The change in voltage stimulates the opening of additional sodium channels (called a voltage gate ion channel), giving what is called a positive feedback loop. Eventually, the cell potential reaches +40 mV, or the action potential. Repolarization. The downswing of repolarization is caused by the closure of sodium ion channels and the opening of potassium ion channels, resulting in the release of positively charged potassium ions (K^+) from the nerve cell. This expulsion seems to restore the localized negative membrane of the cell. Refract phase. The refractory phase is a short period of time after the repolarization stage. Shortly after the sodium gates are opened, they close and enter an inactive conformation where the cell's membrane potential is actually even lower than its baseline -70 mV. The sodium ports cannot be reopened until the membrane has completely repolarized to its normal resting potential, -70 mV. The sodium potassium pump returns sodium ions to the outside and potassium ions to the inside. During the refractory phase this particular area of the nerve cell membrane can not be depolarized; the cell cannot be excited. The chemical synapse process of a chemical reaction at the synapse has some important differences from an electrical reaction. Chemical synapses are much more complex than electrical synapses, which makes them slower, but also allows them to generate different results. Like electrical reactions, chemical reactions involve electrical modifications on the postigaptic membrane, but chemical reactions also require chemical messengers, such as neurotransmitters, to function. Neuron & chemical synapse: This image shows electrical impulses traveling between neurons; the inset shows a chemical reaction that occurs at the synapse. A basic chemical reaction at the synapse undergoes a few additional steps: The action potential (as described above) travels along the membrane of the presynaptic cell until it reaches the synapse. The electrical depolarization of the membrane at the synapsis allows channels to open that are selectively permeable, which means that they specifically only allow the entry of positive sodium ions (Na^+). The ions flow through the presynaptic membrane, rapidly increasing their concentration in the interior. The high concentration activates a set of ion-sensitive proteins attached to vesicles, which are small membrane compartments containing a neurotransmitter chemical. These proteins change shape, causing the membranes of some docked vesicles to merge with the membrane of the presynaptic cell. This opens the vesicles, which release their neurotransmitter content into the synaptic cleft, the narrow space between the membranes of pre- and postsynaptic cells. The neurotransmitter spreads within the forked. Some of it escapes, but the rest of it binds to chemical receptor molecules located on the membrane of the postynaptic cell. The binding of the neurotransmitter causes the receptor molecule to be activated in some way. Several types of activation are possible, depending on the type of neurotransmitter released. In any case, this is the key step through which the synaptic process affects the behavior of the postsynaptic cell. Due to thermal shaking, neurotransmitter molecules eventually break loose from the receptors and drift away. The neurotransmitter is either reabsorbed by the presynaptic cell and for future release, otherwise it is broken metabolically. Differences between electrical and chemical synapses Electrical synapses are faster than chemical synapses because receptors do not need to recognize chemical messengers. The synaptic delay for a chemical synapse is usually about 2 milliseconds, while the synaptic delay for an electrical synapse can be about 0.2 milliseconds. Since electrical synapses do not involve neurotransmitters, electrical neurotransmission is less modifiable than chemical neurotransmission. The answer is always the same sign as the source. For example, depolarization of the presynaptic membrane will always induce a depolarization in the postsynaptic membrane, and vice versa for hyperpolarization. The response in the postynaptic neuron is generally less in amplitude than the source. The amount of attenuation of the signal depends on the membrane resistance of the presynaptic and postsynaptic neurons. Long-term changes can be seen in electrical synapses. For example, changes in electrical synapses in the retina are seen during light and dark alignments of the retina. Neurotransmitters are chemicals that transmit signals from a neuron over a synapse to a target cell. Explain the role of neurotransmitters in the communication process between neurons Key Takeaways Key Points Neurotransmitters dictate communication between cells by binding to specific receptors and depolarizing or hyperpolarizing the cell. Inhibitory neurotransmitters cause hyperpolarization of the postynaptic cell; excitatory neurotransmitters cause depolarization of the postynaptic cell. Too little of a neurotransmitter can cause overaccumulation of proteins, leading to disorders like Alzheimer's; too much of a neurotransmitter can block receptors required for proper brain function, leading to disorders like schizophrenia. The three neurotransmitter systems in the brain are cholinergic, amino acids and biogenic amines. 00:10.300.200-200-200.200-200.14.11.200-194.16.16.10.16.10.11.81.81.200.19.200-14.200-20 vesikel: A membrane-bound compartment located in a cell. action potential: A short-term change in the electrical potential that travels along a cell (such as a nerve or muscle fiber); the basis of neural communication. Neurotransmitters are chemicals that transmit signals from a neuron to a target cell over a synapse. When prompted to deliver messages, they are released from their synaptic vesicles on the presynaptic (give) side of the synapse, diffuse over the synaptic cleft, and bind to receptors in the membrane on the postsynaptic (receiving) side. An action potential is necessary for the release of neurotransmitters, which means that neurons must reach a certain threshold for electrical stimulation in order to complete the reaction. A neuron has a negative charge inside membranes in relation to the outside of cell membranes; when stimulation occurs and the neuron reaches the threshold of tension this polarity is reversed. This allows the signal to pass through the neuron. When the chemical message reaches the axon terminal, channels in the postsynaptic cell membrane are opened up to receive neurotransmitters from vesicles in the presynaptic cell. Inhibitory neurotransmitters cause hyperpolarization of the postynaptic cell (that is, reduce the voltage gradient in the cell, bringing it further away from an action potential), while excitatory neurotransmitters cause depolarization (bringing it closer to an action potential). Neurotransmitters match up with receptors as a key in a lock. A neurotransmitter binds to its receptor and will not bind to receptors for other neurotransmitters, making the binding a specific chemical event. There are several systems of neurotransmitters found at different synapses in the nervous system. The following groups refer to the specific chemicals, and within the groups are specific systems, some of which block other chemicals from entering the cell and some of which allow the entry of chemicals that were blocked earlier. Cholinergic System The cholinergic system is its own neurotransmitter system, and is based on the neurotransmitter acetylcholine (ACh). This system is found in the autonomic nervous system, as well as distributed throughout the brain. The cholinergic system has two types of receptors: the nicotinic receptor and the acetylcholine receptor, which is known as the muscarinic receptor. Both of these receptors are named after chemicals that interact with the receptor in addition to the neurotransmitter acetylcholine. Nicotine, the chemical in tobacco, binds to the nicotine receptor and activates it in the same way as acetylcholine. Muscarine, a chemical product of certain fungi, binds to the muscaric receptor. However, they cannot bind to each other's receptors. Amino acids Another group of neurotransmitters are amino acids, including glutamate (Glu), GABA (gamma-aminobutyric acid, a derivative of glutamate), and glycine (Gly). These amino acids have an amino group and a carboxyl group in their chemical structures. Glutamate is one of the 20 amino acids used to make proteins. Each amino acid neurotransmitter is its own system, namely the glutamatergic, GABAergic, and glycinergic systems. They each have their own receptors and do not interact with each other. Amino acid neurotransmitters are eliminated from the synapse by reuptake. A pump in the cell membrane of the presynaptic element, or sometimes an adjacent glial cell, clears the amino acid from the synaptic cleft so that it can be recovered, repacked in vesicles, and released again. Resusable uptake process: This illustration shows the process of reuptake, in which leftover neurotransmitters are vesicles in the presynaptic cell. Biogenic Amines Another class of the neurotransmitter is the biogenic amine, a group of neurotransmitters made enzymatic from amino acids. They have amino groups in themselves, but do not have carboxyl groups and are therefore no longer classified as amino acids. Neuropeptides A neuropeptide is a neuropeptide molecule that consists of chains of amino acids associated with peptide bonds, similar proteins. However, proteins are long molecules while some neuropeptides are quite short. Neuropeptides are often released during synapses in combination with another neurotransmitter. Dopamine dopamine is the most famous neurotransmitter of the catecholamine group. The brain contains several different dopamine systems, one of which plays an important role in reward-motivated behavior. Most types of reward increase the level of dopamine in the brain, and a variety of addictive drugs increase dopamine neuronal activity. Other brain dopamine systems are involved in motor control and in controlling the release of several other important hormones. Effect on synapse The effect of a neurotransmitter on the postsynaptic element is entirely dependent on the receptor protein. If there is no receptor protein in the membrane of the postynaptic element, the neurotransmitter has no effect. Depolarizing (more likely to reach an action potential) or hyperpolarizing (less likely to reach an action potential) effect is also dependent on the receptor. When acetylcholine binds to the nicotinic receptor, the postynaptic cell is depolarized. However, when acetylcholine binds to the muscarinic receptor, it can cause depolarization or hyperpolarization of the target cell. The amino acid neurotransmitters (glutamate, glycine, and GABA) are almost exclusively associated with just one effect. Glutamate is considered an excitatory amino acid because Glu receptors in the adult cause depolarization of the postynaptic cell. Glycine and GABA are considered inhibitory amino acids, again because their receptors cause hyperpolarization, making the receiving cell less likely to reach an action potential. The right dose Sometimes too little or too much of a neurotransmitter can affect the behavior or health of an organism. The underlying cause of certain neurodegenerative diseases, such as Parkinson's, appears to be related to overaccumulation of proteins, which under normal circumstances would be regulated by the presence of dopamine. On the other hand, when an excess of the neurotransmitter dopamine blocks glutamate receptors, disorders like schizophrenia can occur. Neural networks consist of a series of interconnected neurons, and act as interfaces for neurons to communicate with each other. Explain the different theories of how neural networks work in the body Key Takeaways Key Points The connections between neurons form a very complex network signals or impulses communicated all over the body. The basic varieties of connections between neurons are chemical synapses and electrical gap junctions, through which either chemical or electrical impulses are communicated between neurons. Neural networks consist primarily of axons, which in some cases deliver information as far as two meters. Networks formed by interconnected groups of neurons are capable of a variety of functions; in fact the range of capacity that is possible for even small groups of neurons is beyond our current understanding. Modern science sees the function of the nervous system both in terms of stimulus-response chains and in the form of self-generated operating patterns within neurons. Cell assembly, or hebbian theory, claims that cells that fire together thread together, meaning neural networks can be created through associative experience and learning. Key cell assembly terms: Also called Hebbian theory; the concept of cells that burn wire together,which means neural networks can be created through associative experience and learning. Action Potential: A short-term change in the electrical potential that travels along a cell like a nerve or muscle fiber, and allows nerves to communicate. plasticity: The ability to change and adapt over time. A neural network (or neural pathway) is the interface through which neurons communicate with each other. These networks consist of a series of interconnected neurons whose activation sends a signal or impulse all over the body. Neural Networks: A neural network (or neural pathway) is the complex interface through which neurons communicate with each other. The structure of neural networks The connections between neurons form a very complex network. The basic varieties of connections between neurons are chemical synapses and electrical gap junctions, through which either chemical or electrical impulses are communicated between neurons. The method by which neurons interact with adjacent neurons usually consists of multiple axon terminals connecting through synapses to dendrites on other neurons. If a stimulus creates a strong enough input signal in a nerve cell, the neuron sends an action potential and transmits this signal along its axon. The axon of a nerve cell is responsible for transmitting information over a relatively long distance, and so most neural pathways consist of axons. Some axons are enclosed in a lipid-coated myelin skin, making them appear as a bright white; others who lack myelinsmyas (i.e. are unmyelinated) appear a darker beige color, commonly referred to as gray. The process of synaptic transmission in neurons: Neurons interact with other neurons by sending a signal, or impulse, along their axo and over a synapse to dendrites an adjacent neuron. Some neurons are responsible for information over long distances. For example, motor neurons, which travel from the spinal cord to the muscle, can have axons up to one meter in length in humans. The longest axon in the human body is almost two meters long in tall individuals and goes from the big toe to the medulla oblongata of the brainstem. The capacity of neural networks The basic neuronal function of sending signals to other cells includes the ability of neurons to exchange signals with each other. Networks formed by interconnected groups of neurons can be a variety of functions, including function detection, pattern generation, and timing. In fact, it is difficult to assign limits to the types of information processing that can be performed by neural networks. Given that individual neurons can generate complex temporal patterns of activity independently, the range of capacity is possible for even small groups of neurons beyond current comprehension. But we know we have neural networks to thank for much of our higher cognitive function. Behaviorist Approach Historically, the dominant view of nervous system function as a stimulus-response associator. In this view, neural processing begins with stimuli that activate sensory neurons, producing signals that propagate through chains of connections in the spinal cord and brain, eventually giving rise to activation of motor neurons and thus to muscle contraction or other overt response. Charles Sherrington, in his influential 1906 book The Integrative Action of the Nervous System, developed the concept of stimulus-response mechanisms in much more detail, and behaviorism, the school that dominated psychology through the mid-20th century, tried to explain every aspect of human behavior in stimulus-response terms. Hybrid Approach, However, experimental studies of electrophysiology, beginning in the early 20th century and achieving high productivity by the 1940s, showed that the nervous system contains many mechanisms for generating patterns of activity inherent—without requiring an external stimulus. Neurons were found to be capable of producing regular sequences of action potentials (firing) even in complete isolation. When own active neurons are connected to each other in complex circuits, the possibilities of generating intricate temporal patterns become much more extensive. A modern notion sees the function of the nervous system partly in terms of stimulus-response chains, and partly in terms of self-generated operating patterns; both types of activity interact with each other to generate the entire repertoire of behavior. Hebbian theory In 1949, neuroscientist Donald Hebb suggested that simultaneous activation of cells leads to pronounced increase in synaptic strength between these cells, a theory that is accepted today. Cell assembly, or hebbian theory, claims that cells that fire together thread together, meaning neural networks can be created through associative experience and learning. Since Hebb's discovery, neuroscientists have continued to find evidence of plasticity and modification within neural networks. Network.