Handout 3-J (2021-22)

1. Name and describe the functions of the three main parts of the neuron.

The neuron is composed of 3 main parts: the cell body, dendrites, and axon terminals. The cell body contains genetic information guides the cell’s function and contains nutrients that keep the cell alive. Dendrites receive messages from nearby neurons, and axons conduct electrical impulses, which sends signals to other neurons.

1. Which structural characteristics permit the many possible interconnections among neurons?

The branch-like structure of the dendrites allows the cell to receive inputs from thousands of nearby neurons. The same is true for the axon, which branches out to form a large number of axon terminals that allows it to send messages to as many as 50,000 other neurons.

1. How do glial cells differ from neurons? What three functions do they have in the nervous system?

Glial cells support the neurons by surrounding and holding them in place. The glial cell is also responsible for producing nutrients that neurons need to survive, and absorb toxins and waste produced by neurons. The glial cell is essential for neurons to exist.

1. What causes the resting potential of neurons? Under what condition is a neuron said to be in a state of polarization?

The resting potential of neurons and its negative charge is caused by difference between the number of sodium ions (Na+) and other negative ions. Since the negative ions outnumber the sodium ions, the result is a net negative charge relative to outside the neuron. The neuron is said to be in a state of polarization when it is in this resting state.

1. What chemical changes cause the process of depolarization that creates graded and action potentials? How do the latter differ from one another?

Graded potentials occur when the dendrites or cell body of a neuron are stimulated by the axons of other neurons. These graded potentials can add up to produce an action potential once they reach the action potential threshold, according to the all-or-none law. The action potential requires the inside charge of the neuron to reach +40mV, whereas the graded potential is proportional to the stimulation received by dendrites and the cell body.

1. What is the nature and importance of the myelin sheath? Which disorder results from inadequate myelinization?

The myelin sheath is a fatty layer of insulation that covers the axons and prevent electrical signal from escape during transmissions. Multiple sclerosis is when the body’s immune system attacks and destroy the myelin sheath, which disrupt neuron transmission and results in uncoordinated movements and even paralysis.

1. How do neurotransmitters achieve the processes of excitation and inhibition of postsynaptic neurons?

Neurotransmitters are chemicals produced by neurons that carry messages from one neuron to another. They cross the synapse, a nonphysical connection between the axon terminals and the dendrites of the receiving neuron and bind to specific receptor sites where their “messages” are received by the receiving neuron. There are 2 types of messages: excitation and inhibition. Our body uses a mixture of the two to control our movement and behavior.

1. Describe two methods by which neurotransmitter molecules are deactivated at the synapse.

Upon transmitting their message, neurotransmitters are deactivated their chemical breakdown, which breaks the neurotransmitter down into their basic chemical components, or reuptake (i.e. recycling), where they are taken back to the presynaptic axon terminal (of the cell they came from).

1. Describe the roles of (a) acetylcholine; (b) dopamine; (c) serotonin, and (d) endorphins in psychological functions.

Acetylcholine is involved in memory and muscle functions. Dopamine is an excitatory transmitter that is responsible for our mood and behavior (commonly known as the pleasure hormone). Serotonin is responsible for regulating our mood, eating, sleep, and sexual behavior. Endorphins reduce pain and increases feeling of well-being.

1. What are the three major types of neurons in the nervous system? What are their functions?

The 3 main types of neurons are sensory neurons, motor neurons, and interneurons. Sensory neurons carry input messages from the body to brain and spinal cord. Motor neurons control movement by carrying output impulses from the brain and spinal cord to the body. Interneurons link the body and the brain and is responsible for the interpretation of our environment, as well as our complex behavior.

1. Differentiate between the central nervous system and the peripheral nervous system. What are the two divisions of the peripheral nervous system?

The central nervous system contains the brain and spinal cord, whereas the peripheral nervous system includes all the neurons that connect the central nervous system with muscles, glands, and sensory receptors. The peripheral nervous system includes the somatic nervous system, which allows one to sense and respond to one’s environment, and the autonomic nervous system, which is responsible for regulating unconscious functions, such as breathing and heartrate.

1. Describe the two divisions of the autonomic nervous system, as well as their roles in maintaining homeostasis.

The autonomic nervous system is composed of the sympathetic and parasympathetic nervous system, which both work together to balance internal activity. The sympathetic system arouses the body’s fight or flight response by elevating the body to a “heightened” state, whereas the parasympathetic system relaxes the body into a clam state. The two work together to create a delicate internal balance that can shift depending on the situation.

1. How do spinal reflexes occur?

Spinal reflexes are triggered by external stimuli, such as temperature, in which the spinal cord controls involuntary response to such stimuli. For instance, if you touch something hot, your spinal reflexes will cause you to pull away from the hot object. Sensory receptors -> interneurons -> motor neurons

1. Describe four methods used to study brain-behaviour relations.

Scientists use neuropsychology tests to measure verbal/non-verbal behavior, destruction and stimulation experiments to determine which areas of the brain were responsible for which functions, MRI scans to observe brain activity, and electrical recording to record brain activity.

1. How are CAT scans, PET scans, MRIs, and functional MRIs produced, and how is each used in brain research?

A CT scan is used to study brain structures by using x-rays to take picture of the brain’s interior from many different angles. A PET scan measures brain activity by measuring the levels of glucose in areas of the brain in order to illustrate where neural activity is taking place (this is because neurons consume glucose when they’re active). A functional MRI measures both the structure and activity of the brain through computer adaption of multiple images.

1. In what sense might the structure of the human brain mirror evolutionary development?

The human brain mirrors evolutionary development as the more “advanced” portions of our brain responsible for our cognitive functions and complex behaviors are built on top of a more primitive “core” brain, which we share in common with many other “less advanced” animals. This suggests the the advanced portions of our brain must have been developed through evolution.

1. Which behavioural functions are controlled by the hindbrain structures, namely, the medulla, the pons, and the cerebellum? What occurs with damage to these structures?

The medulla, pons, and cerebellum control vital bodily functions, sleep and consciousness, and voluntary motor control respectively. Damage to each of these areas causes one to lose those functions, based on the extent of the damages. For instance, damage to the cerebellum would result in jerky, uncoordinated movements or paralysis – based on the severity of the damage.

1. Describe the roles played by the ascending and descending reticular formation. Why is it called the “brain’s gatekeeper?”

The ascending portion of the reticular formation regulates consciousness, attention, and sleep. The descending portion either allow or block sensory information from reaching the brain. It is this characteristic that makes it known as the “gatekeeper of the brain”.

1. What is the role of the thalamus in sensory input, and, possibly, in thought and perceptual disorders?

The thalamus directs sensory information to the appropriate area of the brain, where it can then be processed and interpreted. Damage to the thalamus results in thought and perceptual disorders in which the thalamus sends faulty/incorrect information to areas of the brain, causing the person to perceive/experience something that isn’t there.

1. What role does the hypothalamus have in motivating behaviour, hunger, pleasure-pain, and hormonal functions?

The hypothalamus controls basic biological drives/urges, such as hunger, sexual urges, and aggression. These drives influence our behavior (e.g. if we are hungry, we look for food). The hypothalamus is also connected to the nucleus accumbens, which is the “pleasure/rewards center” of the brain. It is also connected with pituitary glands that controls the production of hormones.

1. What is the possible relationship between the hypothalamus and the limbic system in relation to emotion and motivation? What roles do the hippocampus and amygdala play in psychological functions?

The limbic system coordinates behavior to satisfy the motivational and emotional urges produced by the hypothalamus. The hippocampus is responsible for forming and retrieving memories and the amygdala is responsible for forming emotional responses. The two combined allows for the appropriate psychological response to situations (e.g. you feel an emotion when recalling a memory).

1. What are the four lobes of the brain, and where are they located?

The 4 lobes of the brain are the frontal lobe (front of the brain), the parietal lobe (upper side of the brain), the occipital lobe (back of the brain), and the temporal lobe (lower side of the brain). 3 major fissures divide the brain into the different lobes.

1. Differentiate between sensory, motor, and association cortex.

The motor cortex controls voluntary movements (muscular), whereas the sensory cortex receives and processes sensory information from parts of the body, and the association cortex is responsible for forming connections between information (sensations) and is involved in higher functions.

1. How are the somatic sensory and motor cortexes organized?

The somatic sensory and motor cortexes divided into portions/areas that are each responsible for a specific body part. The size of these portions determines the sensitivity and responsiveness of the corresponding body part. For instance, a large portion of our sensory and motor cortexes are dedicated to our hands, which makes more sensitive (allowing for touch) and allow for more precise and coordinated movements.

1. Where are Wernicke’s and Broca’s areas? How are they involved in speech?

Wernicke’s area is located in the temporal lobe and is responsible for interpreting and understanding speech/language. Broca’s area is located in the frontal lobe and is responsible for speech formation.

1. What is the role of association cortex, the “silent areas?”

The association cortex is responsible for making connections between the various inputs the brain receives (e.g. emotions, sensations) and “put them together” to make sense of them.

1. Describe the role of the frontal cortex in higher mental (including “executive”) functions.

The frontal cortex allows for higher-level cognitive functions, such as planning and decision making, and well as abstract thought by processing sensory information that it receives. The frontal cortex and its executive functions are what differentiates us from other animals.

1. What is hemispheric lateralization and what do we know about the functions that are concentrated in the left and right hemispheres?

Hemispheric lateralization is the relative location of functions in either right or left hemisphere of the brain (i.e. the specialization of each side of the brain). From various experiments, we know that the left hemisphere has greater control over the interpretation of words/language, mathematics and logic, whereas the right hemisphere specializes in spatial relations, melodies, and the interpretation of emotions.

1. What roles have (a) the corpus collosum and (b) the optic chiasma played in “split brain” research? Is it reasonable to speak of separate right and left brains in normally functioning people?

The corpus collosum allows the left and right brain to communicate with one another. When the brain’s corpus collosum is cut, the right and left hemispheres of the brain can no longer communicate. The optic chiasm enables both sides of the brain to receive visual information, albeit at different angle. With the corpus collosum cut, each side of the brain is left on its own to interpret the visual information it receives. It is not reasonable to speak of separate right and left brains in normally functional people as the brain is an integrated system, not separate parts divided by function.

1. How is language lateralized in the brain? Are there sex differences?

Generally, language tends to be localized in the left hemisphere of the brain. Although there are minor differences between right and left-handed people, as well as between sexes. For instance, studies show greater left hemisphere activity in men when performing a language task, whereas women show equal activity in both hemispheres.

1. What is neural plasticity? How do age, environment, and behaviour affect plasticity?

Neural plasticity is the ability of neurons to change in structure and functions throughout time (i.e. the brain’s ability to change over time). Factors such as age, environment, and behavior can affect plasticity. The older someone is, the less plastic their brain is. This is because used, weaker synapses deteriorate with old age. Environmental factors, such as more stimulation during brain development, can lead to more neural plasticity (better mental capabilities). Some behavior, such as those of musicians, can also affect neural plasticity.

1. Why do children typically show better recovery of function after brain injury?

Children often recovery faster, and have more complete recovery, than adults as their brains are more plastic due to their young age. Neurons that survive the damage can quickly take on new functions and restore the damaged parts of the brain.