Brain Basics

1 The brain is the body's most complex organ.

a. There are a hundred billion neurons in the human brain, all of which are in use.

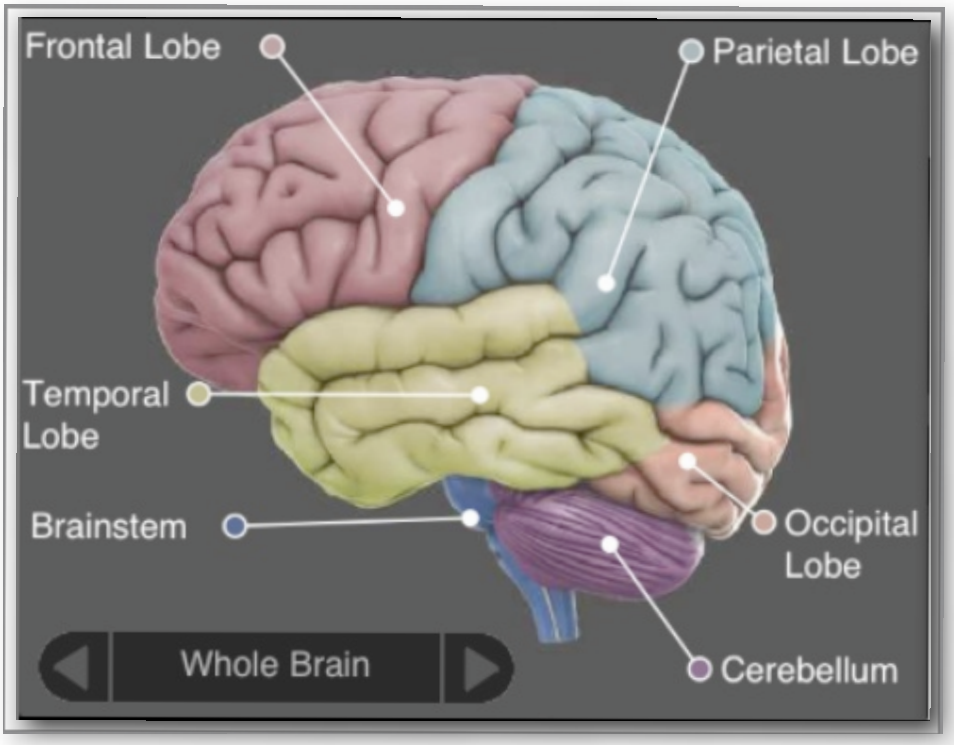
b. Each neuron communicates with many other neurons to form circuits and share information.

c. Proper nervous system function involves coordinated action of neurons in many brain regions.

d. The nervous system influences and is influenced by all other body systems (e.g., cardiovascular, endocrine, gastrointestinal and immune systems).

e. Humans have a complex nervous system that evolved from a simpler one.

f. The function of the cerebral cortex can be understood by dividing it somewhat arbitrarily into zones, much like the geographical arrangement of continents.



g. The *frontal lobe* is responsible for initiating and coordinating motor movements; higher cognitive skills, such as problem solving, thinking, planning, and organizing; and for many aspects of personality and emotional makeup.

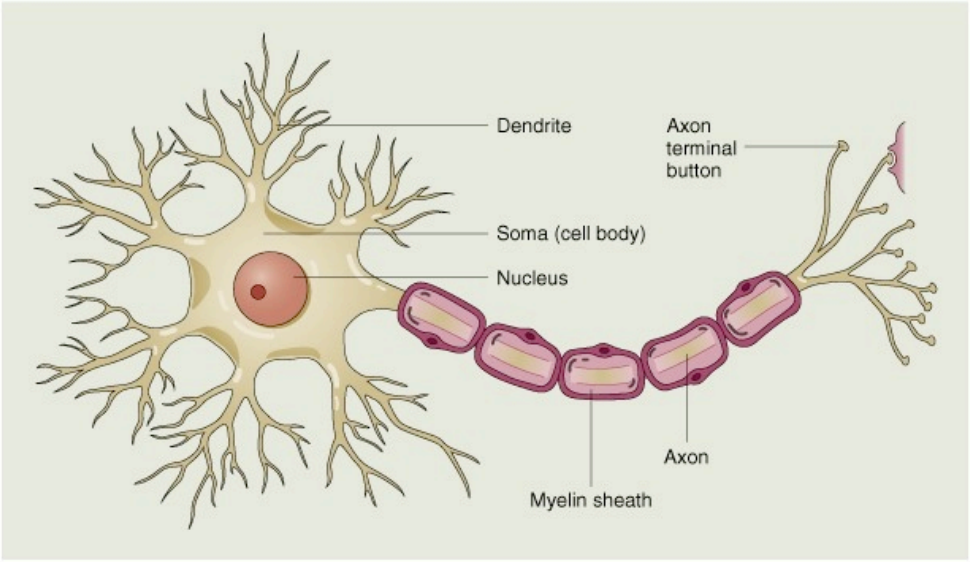
h. The *parietal lobe* is involved with sensory processes, attention, and language. Damage to the right side of the parietal lobe can result in difficulty navigating spaces, even familiar ones. If the left side is injured, the ability to understand spoken and/or written language may be impaired.

i. The *occipital lobe* helps process visual information, including recognition of shapes and colors.

j. The *temporal lobe* helps process auditory information and integrate information from the other senses. Neuroscientists also believe that the temporal lobe has a role to play in short-term memory through its hippocampal formation, and in learned emotional responses through its amygdala.

2 Neurons communicate using both electrical and chemical signals.

a. Cells within the nervous system, called neurons, communicate with each other in unique ways. The neuron is the basic working unit of the brain, a specialized cell designed to transmit information to other nerve cells, muscle or gland cells. A neuron consists of a cell body, dendrites and an axon.



b. When neurons receive or send messages, they transmit electrical signals. Sensory stimuli are converted into electrical signals.

c. Synapses are the contact points where one neuron communicates with another. Synapses are chemical or electrical junctions that allow electrical signals to pass from neurons to other cells.

d. Electrical signals in muscles cause contraction and movement.

e. Changes in the amount of activity at a synapse can enhance or reduce its function.

f. Communication between neurons is strengthened or weakened by an individual's activities, such as exercise, stress, and drug use.

g. All perceptions, thoughts, and behaviors result from combinations of signals among neurons.

3 Genetically determined circuits are the foundation of the nervous system.

a. Neuronal circuits are formed by genetic programs during embryonic development and modified through interactions with the internal and external environment.

b. *Sensory* circuits (sight, touch, hearing, smell, taste) bring information to the nervous system, whereas *motor* circuits send information to muscles and glands.

c. The simplest circuit is a reflex, in which a sensory stimulus directly triggers an immediate motor response.

d. Complex responses occur when the brain integrates information from many brain circuits to generate a response.

e. Simple and complex interactions among neurons take place on time scales ranging from milliseconds to months.

f. The brain is organized to recognize sensations, initiate behaviors, and store and access memories that can last a lifetime.

4 Life experiences change the nervous system.

a. Differences in genes and environments make the brain of each animal unique.

b. Most neurons are generated early in development and survive for life.

c. Some injuries harm nerve cells, but the brain often recovers from stress, damage, or disease.

d. Continuously challenging the brain with physical and mental activity helps maintain its structure and function — "use it or lose it."

e. Neuronal death is a natural part of development and aging.

f. Some neurons continue to be generated throughout life and their production is regulated by hormones and experience.

5 Intelligence arises as the brain reasons, plans, and solves problems.

a. The brain makes sense of the world by using all available information, including senses, emotions, instincts and remembered experiences.

b. Emotions are based on value judgments made by our brains and are manifested by feelings as basic as love and anger and as complex as empathy and hate.

c. The brain learns from experiences and makes predictions about best actions in response to present and future challenges.

d. Consciousness depends on normal activity of the brain.

6 The brain makes it possible to communicate knowledge through language.

a. Languages are acquired early in development and facilitate information exchange and creative thought.

b. Communication can create and solve many of the most pressing problems humankind faces.

7 The human brain endows us with a natural curiosity to understand how the world works.

a. The nervous system can be studied at many levels, from complex behaviors such as speech or learning, to the interactions among individual molecules.

b. Research can ultimately inform us about mind, intelligence, imagination, and consciousness.

c. Curiosity leads us to unexpected and surprising discoveries that can benefit humanity.