MODULE 6

The Cerebral Cortex and Our Divided Brain

MODULE OVERVIEW

Module 6 is concerned with the structures and functions of the brain's ultimate control and information-processing center, the cerebral cortex. Studies of split-brain patients have given researchers a great deal of information about the specialized functions of the brain's right and left hemispheres.

Many students find the technical material in this module difficult to master. Learning this material will require a great deal of rehearsal. Working the module review several times, drawing and labeling brain diagrams, and mentally reciting terms are all useful techniques for rehearsing this type of material.

NOTE: Answer guidelines for all Module 6 questions begin on page 60.

MODULE REVIEW

First, skim each section, noting headings and boldface items. After you have read the section, review each objective by answering the fill-in and essay-type questions that follow it. In some cases, Study Tips explain how best to learn a difficult concept and Applications help you to know how well you understand the material. As you proceed, evaluate your performance by consulting the answers on page 60. Do not continue with the next section until you understand each answer. If you need to, review the section in the textbook before continuing.

The Cerebral Cortex

Objective 6-1: Identify the various regions of the cerebral cortex, and describe their functions.

1. The most complex functions of human behavior are linked to the most developed part of the brain, the Cerebral cortex. This thin layer of interconnected neural cells is the body's ultimate control and Infomation-processing center.

2. Compared with the cortexes of lower mammals, the human cortex has a more wrinkled (smoother/more wrinkled) surface. This increases (increases/decreases) the overall surface area of our brains.

3. The cells that support, protect, and nourish cortical neurons are called glial cell. These cells may also play a role in learning and thinking.

4. Each hemisphere's cortex is subdivided into four lobes, separated by prominent fissures, or folds. List the four lobes of the brain.
   a. frontal
   b. parietal
   c. occipital
   d. temporal

5. Electrical stimulation of one side of the motor cortex, an arch-shaped region at the back of the frontal lobe, will produce movement on the opposite side of the body. The more precise the control needed, the greater (smaller/greater) amount of cortical space occupied.

6. Researchers investigating Brain computer interfaces believe that one day mind-reading computers may enable paralyzed people to control machines directly with their thoughts. Clinical trials involving cognitive neural prosthetics are now under way for people. For example, recording

electrodes implanted in the motor cortex of a 25-year-old man's brain have enabled him to mentally control a TV, draw shapes on a screen, and play video games.

7. At the front of the parietal lobes lies the sensory cortex, which, when stimulated, elicits a sensation of touch. The more sensitive a body region, the greater the area of sensory cortex devoted to it.

8. Visual information is received in the occipital lobes, whereas auditory information is received in the temporal lobes.

9. Areas of the brain that don't receive sensory information or direct movement but, rather, integrate and interpret information received by other regions are known as association areas. Approximately 3/4 of the human cortex is of this type. Such areas in the frontal lobe are involved in judging, planning, and processing of new memories and in some aspects of personality. In the parietal lobe, these areas enable mathematical and spatial reasoning, and an area of the temporal lobe enables us to recognize faces.

10. Although the mind's subsystems are localized in particular brain regions, the brain (does/does not) act as a unified whole.

APPLICATIONS:

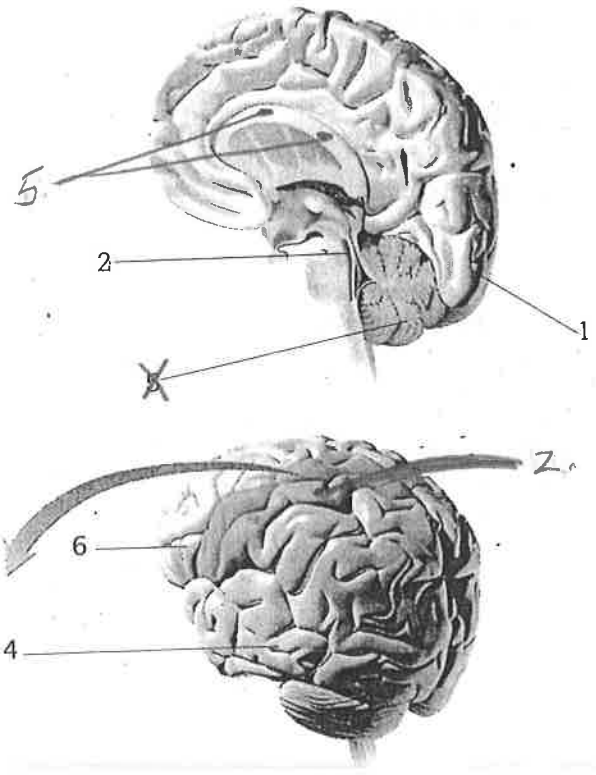
11. Raccoons have much more precise control of their paws than dogs. You would expect that raccoons have more cortical space dedicated to "paw control" in the _____ of their brains.
    a. frontal lobes
    b. parietal lobes
    c. temporal lobes
    d. occipital lobes

12. In the diagrams to the right, the numbers refer to brain locations that have been damaged. Match each location with its probable effect on behavior.

Location	
a	1.
b	2.
c	3.
d	4.
e	5.
f	6.

Behavioral Effect

a. vision disorder
b. insensitivity to touch
c. motor paralysis
d. hearing problem
e. split brain
f. altered personality



The Brain's Plasticity

Objective 6-2: Discuss the brain's ability to reorganize itself, and define *neurogenesis*.

13. The quality of the brain that makes it possible for undamaged brain areas to take over the functions of damaged regions is known as plasticity. This quality is especially apparent in the brains of (young children/adolescents/adults).

14. Although severed neurons usually (will/will not) regenerate, some neural tissue can reorganize in response to damage. The form of therapy aimed at helping to reprogram a damaged brain is called constraint-induced therapy. New evidence suggests that adult mice, birds, monkeys, and humans (can/cannot) generate new brain cells through a process called neurogenesis. Research also reveals the existence of master stem cells in the human embryo that can develop into any type of brain cell.

Our Divided Brain

Objective 6-3: Explain how split-brain research helps us understand the functions of our left and right hemispheres.

15. The brain's two sides serve differing functions, which is referred to as hemispheric specialization, or lateralization. Because damage to the left hemisphere will impair such important functions as reading, writing, speaking, arithmetic reasoning, and understanding, the right hemisphere was thought to be a subordinate or minor hemisphere.

16. In treating several patients with severe epilepsy, Philip Vogel and Joseph Bogen separated the two hemispheres of the brain by cutting the corpus callosum. When this structure is severed, the result is referred to as a split brain.

17. In a split-brain patient, only the right hemisphere will be aware of an unseen object held in the left hand. In this case, the person would not be able to name the object. When different words are shown in the left and right visual fields, if the patient fixates on a point on the center line between the fields, the patient will be able to say only the word shown on the right.

Explain why a split-brain patient would be able to read aloud the word *pencil* flashed to his or her right visual field, but would be unable to identify a *pencil* by touch using only the left hand.

project to the left hemisphere language center. left hand right hemisphere could not guide the hand to identify by touch

18. When the "two minds" of a split brain are at odds, the left hemisphere tries to rationalize what it doesn't understand. The right hemisphere often acts on autopilot. This phenomenon demonstrates that the unconscious mind (can/cannot) control our behavior.

APPLICATIONS:

19. To pinpoint the location of a tumor, a neurosurgeon electrically stimulated parts of the patient's sensory cortex. If the patient was conscious during the procedure, which of the following was probably experienced?
    a. "hearing" faint sounds
    b. "seeing" random visual patterns
    c. movement of the arms or legs
    d. a sense of having the skin touched

20. A split-brain patient has a picture of a knife flashed to her left hemisphere and that of a fork to her right hemisphere. She will be able to
    a. identify the fork using her left hand.
    b. identify a knife using her left hand.
    c. identify a knife using either hand.
    d. identify a fork using either hand.

21. Dr. Johnson briefly flashed a picture of a key in the right visual field of a split-brain patient. The patient could probably
   a. verbally report that a key was seen.
   b. write the word key using the left hand.
   c. draw a picture of a key using the left hand.
   d. do none of these things.

Right-Left Differences in the Intact Brain

22. Deaf people use the left hemisphere to process sign language.

23. Although the left hemisphere is better at making literal interpretations of language, the right hemisphere excels in making inferences, modulating our speech, orchestrating our sense of self, and perceiving objects.

24. (Close-Up) In all cultures of the world, most of the human population is (right/left-handed). Genetic factors (play/do not play) a role in handedness. This handedness bias is unique to humans and to our nearest primate relatives.

APPLICATION:

25. Anton is applying for a technician's job with a neurosurgeon. In trying to impress his potential employer with his knowledge of the brain, he says, "After my father's stroke I knew immediately that the blood clot had affected his left cerebral hemisphere because he no longer recognized a picture of his friend." Should Anton be hired?
   a. Yes. Anton obviously understands brain structure and function.
   b. No. The right hemisphere, not the left, specializes in picture recognition.
   c. Yes. Although blood clots never form in the left hemisphere, Anton should be rewarded for recognizing the left hemisphere's role in picture recognition.
   d. No. Blood clots never form in the left hemisphere, and the right hemisphere is more involved than the left in recognizing pictures.

PROGRESS TEST

Multiple-Choice Questions

Circle your answers to the following questions and check them with the answers beginning on page 60. If your answer is incorrect, read the explanation for why it is incorrect and then consult the text.

1. Which of the following is typically controlled by the right hemisphere?
   a. language
   b. learned voluntary movements
   c. arithmetic reasoning
   d. perceptual tasks

2. The increasing complexity of animals' behavior is accompanied by an
   a. increase in the size of the visual cortex.
   b. increase in the depth of the corpus callosum.
   c. increase in the size of the frontal lobes.
   d. increase in the amount of association area.

3. An experimenter flashes the word FLYTRAP onto a screen facing a split-brain patient so that FLY projects to her right hemisphere and TRAP to her left hemisphere. When asked what she saw, the patient will
   a. say she saw FLY.
   b. say she saw TRAP.
   c. point to FLY using her right hand.
   d. point to TRAP using her left hand.

4. Cortical areas that are not primarily concerned with sensory, motor, or language functions are
   a. called projection areas.
   b. called association areas.
   c. located mostly in the parietal lobe.
   d. located mostly in the temporal lobe.

5. The visual cortex is located in the
   a. occipital lobe.
   b. temporal lobe.
   c. frontal lobe.
   d. parietal lobe.

6. Which of the following is typically controlled by the left hemisphere?
   a. making inferences
   b. word recognition
   c. the left side of the body
   d. perceptual skills

7. In the brain, I outnumber neurons. I also provide nutrients to the neurons and help remove excess neurotransmitters. I am a
   a. hormone.
   b. myelin sheath.
   c. glial cell.
   d. gland.

8. Research has found that the amount of representation in the motor cortex reflects the
   a. size of the body parts.
   b. degree of precise control required by each of the parts.
   c. sensitivity of the body region.
   d. area of the occipital lobe being stimulated by the environment.

9. The nerve fibers that enable communication between the right and left cerebral hemispheres and that have been severed in split-brain patients form a structure called the
   a. temporal lobes.
   b. association areas.
   c. corpus callosum.
   d. parietal lobes.

10. Beginning at the front of the brain and moving toward the back of the head, then down the skull and back around to the front, which of the following is the correct order of the cortical regions?
    a. occipital lobe; temporal lobe; parietal lobe; frontal lobe
    b. temporal lobe; frontal lobe; parietal lobe; occipital lobe
    c. frontal lobe; occipital lobe; temporal lobe; parietal lobe
    d. frontal lobe; parietal lobe; occipital lobe; temporal lobe

11. Following a nail gun wound to his head, Jack became more uninhibited, irritable, dishonest, and profane. It is likely that his personality change was the result of injury to his
    a. parietal lobe.
    b. temporal lobe.
    c. occipital lobe.
    d. frontal lobe.

12. Three-year-old Marco suffered damage to the speech area of the brain's left hemisphere when he fell from a swing. Research suggests that
    a. he may never speak again.
    b. his motor abilities may improve so that he can easily use sign language.
    c. his right hemisphere may take over much of the language function.
    d. his earlier experience with speech may enable him to continue speaking.

Matching Items

Match each structure or term with its corresponding function or description.

Structures or Terms

___ 1. right hemisphere
___ 2. temporal lobes
___ 3. occipital lobes
___ 4. plasticity
___ 5. neurogenesis
___ 6. association areas
___ 7. left hemisphere
___ 8. glial cells

Functions or Descriptions

a. the formation of new neurons
b. specializes in rationalizing reactions
c. support cells of the nervous system
d. specializes in spatial relations
e. brain areas containing the auditory cortex
f. brain areas containing the visual cortex
g. the brain's capacity for modification
h. brain areas involved in higher mental functions

TERMS AND CONCEPTS TO REMEMBER

Using your own words, on a piece of paper write a brief definition or explanation of each of the following terms.

1. cerebral cortex
2. glial cells
3. frontal lobes
4. parietal lobes
5. occipital lobes
6. temporal lobes
7. motor cortex
8. sensory cortex
9. association areas
10. plasticity
11. neurogenesis
12. corpus callosum
13. split brain