

# Tools of Discovery and Older Brain Structures

## MODULE OVERVIEW

Knowledge of the workings of the brain has increased with advances in neuroscientific methods. These include the EEG, PET scans, MRI scans, and, most recently, fMRI, which allows researchers to view brain activity as a person performs a task.

The older brain structures—the brainstem and limbic system—function in much the same way for us as they did for our distant ancestors. These structures sustain basic life functions and enable memory, emotions, and basic drives.

NOTE: Answer guidelines for all Module 5 questions begin on page 52.

## MODULE REVIEW

First, skim each section, noting headings and bold-face 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 beginning on page 52. 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 Tools of Discovery: Having Our Head Examined

Objective 5-1: Describe several techniques for studying the brain's connections to behavior and mind.

1. Researchers sometimes study brain function by producing lesions or by selectively destroying brain cells. The oldest technique for studying the brain involves clinical observation of patients with brain injuries or diseases.

2. The (EEG) electroencephalogram is an amplified recording of the waves of electrical activity that sweep across the brain's surface.

3. The technique depicting the level of activity of brain areas by measuring the brain's consumption of glucose is called the positron emission tomography scan or PET.

Briefly explain the purpose of the PET scan.

Radioactive glucose consumption shows brain areas most active during various activities

4. A technique that produces clearer images of the brain (and other body parts) by using magnetic fields and radio waves is known as MRI magnetic resonance imaging.

5. By comparing scans taken less than a second apart, the functional MRI detects oxygen-laden bloodflow to the part of the brain thought to control the bodily activity being studied. Using this technique, researchers found that bloodflow to the back of the brain \_\_\_\_\_ (increases/decreases) when people view a scene because that is where visual information is processed.

STUDY TIP/APPLICATIONS: To help keep the various research methods for studying the brain straight, think of the methods as falling into two categories: (1) those that measure ongoing electrical or metabolic brain activity in real time (EEG, PET scan, fMRI) and (2) those that merely provide a momentary picture of the brain's anatomical structure (MRI).

6. a. Which method would be most useful to a neurologist attempting to locate a tumor in a patient's brain?

MRI

- b. Which method would be most useful to a researcher attempting to pinpoint the area of the brain that is most critical to speaking aloud?

PET or fMRI

- c. What are some other instances when a researcher would be best advised to use methods that give a picture of the brain's structure?

structure changes or comparing brains - like men's and women's brains.

- d. What are some other instances when a researcher would be best advised to use methods that measure brain activity?

areas of strong emotions or abnormal areas - memory or language problems.

### Older Brain Structures

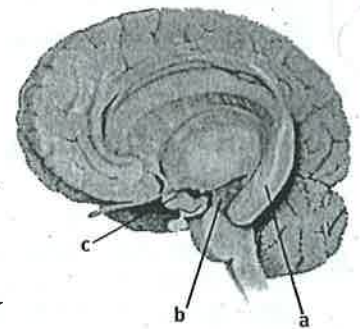
Objective 5-2: Describe the components of the brainstem, and summarize the functions of the brainstem, thalamus, and cerebellum.

7. The oldest and innermost region of the brain is the brain stem.
8. At the base of the brainstem, where the spinal cord enters the skull, lies the medulla, which controls breathing and heartbeat. Just above this part is the pons, which helps coordinate movements.
9. Nerves from each side of the brain cross over to connect with the body's opposite side in the brainstem.
10. At the top of the brainstem sits the thalamus, which serves as the brain's sensory switchboard, receiving information from all the senses except smell and routing it to the regions dealing with those senses. These egg-shaped structures also receive replies from the higher regions, which they direct to the medulla and to the cerebellum.

11. The finger-shaped network of neurons, the reticular formation, is contained inside the brainstem and plays an important role in controlling arousal. Electrically stimulating this area will produce an alert (awake) animal. Lesioning this area will cause an animal to lapse into a coma.
12. At the rear of the brainstem lies the cerebellum. It influences one type of nonverbal learning and memory. It also helps us judge time, modulate our emotions, and discriminate sounds and textures; and it coordinates voluntary movement and balance control.
13. The lower brain functions occur without conscious effort, indicating that our brains process most information (inside/outside) of our awareness.

Objective 5-3: Describe the structures and functions of the limbic system.

14. Between the brainstem and cerebral hemispheres is the limbic system. One component of this system that processes conscious memories is the hippocampus (see a in drawing).
15. Aggression or fear will result from stimulation of different regions of the lima-bean-sized neural clusters, the amygdala (see b).
16. We must remember, however, that the brain (is/is not) neatly organized into structures that correspond to our categories of behavior. For example, aggressive behavior (does/does not) involve neural activity in many brain levels.
17. Below the thalamus is the hypothalamus (c) which regulates bodily maintenance behaviors such as hunger, thirst,



body temperature, and sexual behavior. This area also regulates behavior by secreting hormones that enable it to control the pituitary gland. Olds and Milner discovered that this region also contains reward centers, which animals will work hard to have stimulated.

18. Some researchers believe that alcohol dependence, drug abuse, binge eating, and other addictive disorders may stem from a genetic reward deficiency syndrome in the natural brain systems for pleasure and well-being.

#### APPLICATIONS:

19. The part of the human brain that is most like that of a fish is the
- cortex.
  - limbic system.
  - brainstem.
  - right hemisphere.
20. If Dr. Rogers wishes to conduct an experiment on the effects of stimulating the reward centers of a rat's brain, he should insert an electrode into the
- thalamus.
  - amygdala.
  - hypothalamus.
  - brainstem.
21. In primitive vertebrate animals, the brain primarily regulates \_\_\_\_\_; in lower mammals, the brain enables \_\_\_\_\_.
- emotion; memory
  - memory; emotion
  - survival functions; emotion
  - reproduction; emotion
22. A scientist from another planet wishes to study the simplest brain mechanisms underlying emotion and memory. You recommend that the scientist study the
- brainstem of a frog.
  - limbic system of a dog.
  - hypothalamus of a monkey.
  - hypothalamus of a human.

23. Dr. Frankenstein made a mistake during neurosurgery on his monster. After the operation, the monster "saw" with his ears and "heard" with his eyes. It is likely that Dr. Frankenstein "rewired" neural connections in the monster's
- hypothalamus.
  - cerebellum.
  - amygdala.
  - thalamus.

## PROGRESS TEST

### Multiple-Choice Questions

Circle your answers to the following questions and check them with the answers on page 53. If your answer is incorrect, read the explanation for why it is incorrect and then consult the text.

- The brain research technique that involves monitoring the brain's usage of glucose is called (in abbreviated form) the
  - PET scan.
  - fMRI.
  - EEG.
  - MRI.
- Though there is no single "control center" for emotions, their regulation is primarily attributed to the brain region known as the
  - limbic system.
  - reticular formation.
  - brainstem.
  - cerebellum.
- Following a head injury, a person has ongoing difficulties staying awake. Most likely, the damage occurred to the
  - thalamus.
  - hypothalamus.
  - reticular formation.
  - cerebellum.
- The technique that uses magnetic fields and radio waves to produce computer images of structures within the brain is called
  - the EEG.
  - a lesion.
  - a PET scan.
  - MRI.
- Jessica experienced difficulty keeping her balance after receiving a blow to the back of her head. It is likely that she injured her
  - medulla.
  - thalamus.
  - hypothalamus.
  - cerebellum.
- Moruzzi and Magoun caused a cat to lapse into a coma by severing neural connections between the cortex and the
  - reticular formation.
  - hypothalamus.
  - thalamus.
  - cerebellum.

**Matching Items**

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

**Structures**

- d 1. hypothalamus
- c 2. lesion
- a 3. EEG
- f 4. fMRI
- g 5. reticular formation
- b 6. MRI
- e 7. thalamus
- j 8. cerebellum
- h 9. amygdala
- i 10. medulla
- k 11. brainstem

**Functions or Descriptions**

- a. amplified recording of brain waves
- b. technique that uses radio waves and magnetic fields to image brain anatomy
- c. serves as sensory switchboard
- d. contains reward centers
- e. tissue destruction
- f. technique that uses radio waves and magnetic fields to show brain function
- g. helps control arousal
- h. influences rage and fear
- i. regulates breathing and heartbeat
- j. enables coordinated movement
- k. oldest part of the brain

**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. lesion
- 2. electroencephalogram (EEG)
- 3. PET (positron emission tomography scan)
- 4. MRI (magnetic resonance imaging)
- 5. fMRI (functional magnetic resonance imaging)
- 6. brainstem
- 7. medulla
- 8. thalamus
- 9. reticular formation
- 10. cerebellum
- 11. limbic system
- 12. amygdala
- 13. hypothalamus