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18.1 Anatomy and Physiology

The central nervous system consists of the brain and the spinal cord. The major anatomical divisions of the brain are the cerebrum and the cerebellum, together weighing about 1400 g in the adult. The cells in the brain are classified as glia or neurons. About 10,000 different types of neurons totaling approximately 100 billion neurons comprise the human brain. The cerebral cortex consists of two hemispheres connected by a large mass of white matter called the corpus callosum. The surface layer of each hemisphere is folded into gyri comprising the gray matter. The brain is divided into functional areas called the frontal lobe (anterior to the central sulcus) and the parietal lobe (posterior to this sulcus). The occipital lobe lies below the parieto-occipital sulcus, and the temporal lobe is situated below the lateral sulcus (Figs. 18.1, 18.2). Knowledge of cross sectional anatomy of the brain (Figs. 18.3–18.5) is a prerequisite for proper interpretation of brain imaging since tomographic imaging is the rule in current functional neuroimaging.

Neuronal blood flow utilization is related primarily to synaptic activity at the neuron cell body; thus gray matter requires about four times as much blood flow as white matter. In the normal brain the overall determinant of regional cerebral blood flow (rCBF) is dependent on vascular integrity, cerebral anatomy, and cerebral function. Since diseases of the brain can disrupt
Fig. 18.1. Diagram of the lateral surface of the brain illustrating its main anatomic features (AHE)

Fig. 18.2. Diagram of the brain illustrating the main internal structures (AHE)

one or more of these functions, for accurate diagnosis it is important to integrate these three physiological functions with the pattern of rCBF change from normalcy to arrive at an accurate diagnosis of disease. In this chapter a review of radiopharmaceuticals commonly used to diagnose brain diseases is presented. This is followed by classes of disease which result in relatively specific patterns of abnormal tracer distribution, thus allowing for a specific diagnosis from the nuclear medicine scan.

Interpretation of brain SPECT studies depends on a background of neuroanatomy which with current techniques allow co-registration of MRI and CT with the functional images of SPECT and PET (Figs. 18.3 - 18.5). Perfusion changes noted with SPECT radiotracers are appreciated due to the differences in the cortical gray to white matter perfusion related to the large amount of neurons in the cortex. Coupling of perfusion and metabolism provides functional information regarding the state of the patient during tracer injection with Tc-99m-HMPAO and Tc-99m-ECD. Outside the US other perfusional tracers in use include I-123-IMP. Magnetic resonance imaging evaluating the degree of myelination, I-123-IMP SPECT, and O-15-PET studies have re-