Organization of the Nervous System, Basic Functions of Synapses, and Neurotransmitters. The nervous system is unique in the vast complex- ity of thought processes and control actions it can per- form. It receives each min- ute literally millions of bits of information from the differ- ent sensory nerves and sensory organs and then integrates all these to determine responses to be made by the body. Before beginning this discussion of the nervous sys- tem, the reader should review Chapters 5 and 7, which present the principles of membrane potentials and trans- mission of signals in nerves and through neuromuscular junctions. General Design of the Nervous System Central Nervous System Neuron: The Basic Functional Unit : The central nervous system contains more than 100 bil- lion neurons. Figure 45–1 shows a typical neuron of a type found in the brain motor cortex. Incoming signals enter this neuron through synapses located mostly on the neu- ronal dendrites, but also on the cell body. For different types of neurons, there may be only a few hundred or as many as 200,000 such synaptic connections from input fibers. Conversely, the output signal travels by way of a single axon leaving the neuron. Then, this axon has many separate branches to other parts of the nervous system or peripheral body. A special feature of most synapses is that the signal normally passes only in the forward direction, from the axon of a preceding neuron to dendrites on cell mem- branes of subsequent neurons. This forces the signal to travel in required directions for performing specific nervous functions. Sensory Part of the Nervous System—Sensory Receptors Most activities of the nervous system are initiated by sensory experiences that excite sensory receptors, whether visual receptors in the eyes, auditory receptors in the ears, tactile receptors on the surface of the body, or other kinds of receptors. These sensory experiences can either cause immediate reactions from the brain, or memories of the experiences can be stored in the brain for minutes, weeks, or years and determine bodily reactions at some future date. Figure 45–2 shows the somatic portion of the sen- sory system, which transmits sensory information from the receptors of the entire body surface and from some deep structures. This information enters the central ner- vous system through peripheral nerves and is conducted immediately to multiple sensory areas in (1) the spinal cord at all levels; (2) the reticular substance of the medulla, pons, and mesencephalon of the brain; (3) the cerebellum; (4) the thalamus; and (5) areas of the cerebral cortex. Motor Part of the Nervous System—Effectors The most important eventual role of the nervous system is to control the various bodily activities. This is achieved by controlling (1) contraction of appropriate skeletal muscles throughout the body, (2) contraction of smooth muscle in the internal organs, and (3) secretion of active chemical substances by both exocrine and endocrine glands in many parts of the body. These activities are col- lectively called motor functions of the nervous system, and the muscles and glands are called effectors because they are the actual anatomical structures that perform the functions dictated by the nerve signals. Figure 45–3 shows the “skeletal” motor nerve axis of the nervous system for controlling skeletal muscle con- traction. Operating parallel to this axis is another sys- tem, called the autonomic nervous system, for controlling smooth muscles, glands, and other internal bodily sys- tems; this is discussed in Chapter 60. Note in Figure 45–3 that the skeletal muscles can be controlled from many levels of the central nervous system, including (1) the spinal cord; (2) the reticular substance of the medulla, pons, and mesencephalon; (3) the basal gan- glia; (4) the cerebellum; and (5) the motor cortex. Each of these areas plays its own specific role, the lower regions

concerned primarily with automatic, instantaneous mus- cle responses to sensory stimuli, and the higher regions.