rise to preganglionic efferent fibers that exit from the brain stem or spinal cord and terminate in motor ganglia. The sympathetic preganglionic fibers leave the CNS through the thoracic, lumbar, and (according to new information) sacral spinal nerves. The parasympathetic preganglionic fibers leave the CNS through the cranial nerves (especially the third, seventh, ninth, and tenth).

Most thoracic and lumbar sympathetic preganglionic fibers are short and terminate in ganglia located in the **paravertebral** chains that lie on either side of the spinal column. Most of the remaining sympathetic preganglionic fibers are somewhat longer and terminate in **prevertebral ganglia,** which lie in front of the vertebrae, usually on the ventral surface of the aorta. From the ganglia, postganglionic sympathetic fibers run to the tissues innervated. Some preganglionic parasympathetic fibers terminate in parasympathetic ganglia located outside the organs innervated: the **ciliary, pterygopalatine, submandibular,** and **otic ganglia.** However, the majority of parasympathetic preganglionic fibers terminate on ganglion cells distributed diffusely or in networks in the walls of the innervated organs. Several **pelvic ganglia** are innervated by sacral preganglionic nerves that are ontogenetically similar to sympathetic preganglionic fibers (see Box: Sympathetic Sacral Outflow). Note that the terms "sympathetic" and "parasympathetic" are anatomic designations and do not depend on the type of transmitter chemical released from the nerve endings nor on the kind of effect—excitatory or inhibitory—evoked by nerve activity.

In addition to these clearly defined peripheral motor portions of the ANS, large numbers of afferent fibers run from the periphery to integrating centers, including the enteric plexuses in the gut, the autonomic ganglia, and the CNS. Many of the sensory pathways that end in the CNS terminate in the hypothalamus and medulla and evoke reflex motor activity that is carried to the effector cells by the efferent fibers described previously. There is increasing evidence that some of these sensory fibers also have peripheral motor functions.

The **enteric nervous system (ENS)** is a large and highly organized collection of neurons located in the walls of the gastrointestinal (GI) system (Figure 6–2). With more than 150 million

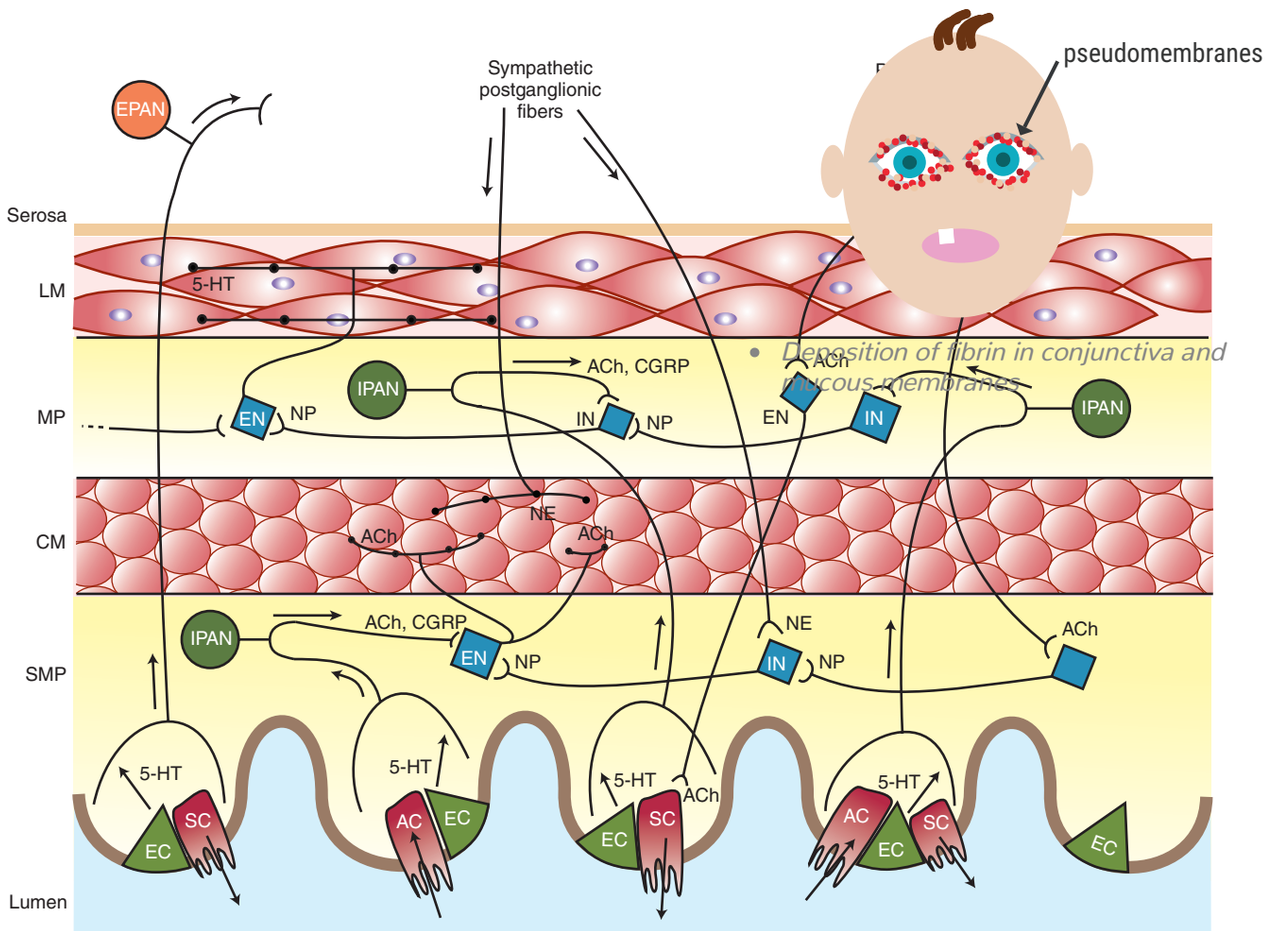

FIGURE 6–2 A highly simplified diagram of the intestinal wall and some of the circuitry of the enteric nervous system (ENS). The ENS receives input from both the sympathetic and the parasympathetic systems and sends afferent impulses to sympathetic ganglia and to the central nervous system. Many transmitter or neuromodulator substances have been identified in the ENS; see Table 6–1. ACh, acetylcholine; AC, absorptive cell; CGRP, calcitonin gene-related peptide; CM, circular muscle layer; EC, enterochromaffin cell; EN, excitatory neuron; EPAN, extrinsic primary afferent neuron; 5-HT, serotonin; IN, inhibitory neuron; IPAN, intrinsic primary afferent neuron; LM, longitudinal muscle layer; MP, myenteric plexus; NE, norepinephrine; NP, neuropeptides; SC, secretory cell; SMP, submucosal plexus.