NEURON

3.1 The Neuron: Its Major Regions

Neurons (nerve cells) are the functional units of the nervous system; they are cells that are specialized to receive, conduct, and transmit electrochemical signals. Like other cells, neurons are composed of a clear inner fluid, called **cytoplasm**, enclosed within a **cell membrane**. The cell membrane is semipermeable; that is, some molecules can pass through it, whereas others cannot.

Neurons come in a wide variety of sizes and shapes, but in most the following four regions are readily discernible. (1) The **cell body**, or *soma*, is the metabolic center of the neuron; it is the region of the neuron that coordinates the processes that are critical for the cell's survival. (2) The **dendrites** are the short bushy fibers that branch from the cell body; their primary function is to receive incoming signals from other neurons. (3) The **axon** is the single long fiber that extends from the cell body; its function is to conduct signals from the cell body to other sites in the nervous system. (4) The **buttons** are the button-like terminal endings of the *axon branches*; they are sites from which the neuron transmits most of its signals to other cells.

Typically, signals from other neurons are received by the dendrites; and, to some extent, the cell body. Then, they are conducted through the cell body, along the axon, and finally to the buttons, which transmit them to other cells.

Cytoplasm (SITE oh plazm)
The clear inner fluid of neurons and other cells.

Cell membrane
The semipermeable membrane that encloses the cytoplasm of neurons and other cells; the wall of the cell.

Cell body
The metabolic center of the neuron; also called the *soma* (pronounced SOE ma).

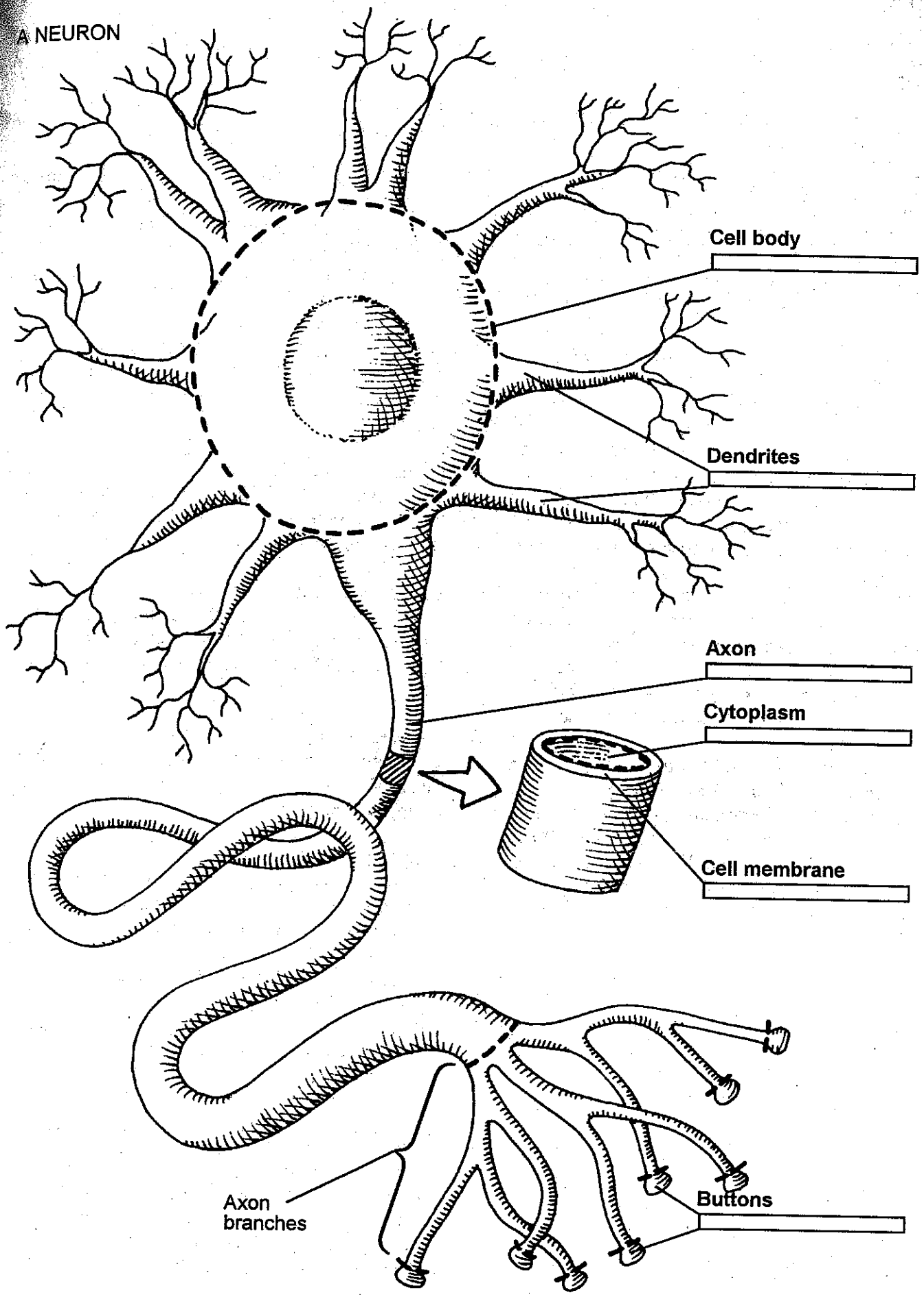
Dendrites (DEN drites)
The short bushy fibers that branch out from the cell body; they constitute the major signal-receiving area of the neuron.

Axon
The single long fiber that extends from a neuron's cell body; its function is to conduct neural signals from the cell body to other parts of the nervous system.

Buttons
The button-like terminal endings of the axon branches.

Coloring notes
First, color all 10 dendrites including the dendrite branches, which are represented by lines. Next, color the 8 buttons—do not color over the dashed lines and into the axon branches. Finally, color the cell body, axon, cell membrane, and cytoplasm.

A NEURON


Cell body
Dendrites
Axon
Cytoplasm
Cell membrane
Axon branches
Buttons

3.4 Neural Conduction Through Dendrites and Cell Body

Together the dendrites and cell body are referred to as the **receptive area** of the neuron. This is because neurons typically receive most of their input from the thousands of buttons of other neurons that cover the dendrites and cell body. Between each button and the receptive membrane is a narrow gap called a **synapse**. Although synapses are most prevalent on the dendrites and cell body, there are some on other parts of the neuron as well.

The release of neurotransmitter molecules at some synapses produces small electrical charges that tend to excite the postsynaptic neuron; these charges are called *excitatory postsynaptic potentials* or *EPSPs*. Activity at other synapses produces small electrical charges that tend to inhibit the postsynaptic neuron; these charges are called *inhibitory postsynaptic potentials* or *IPSPs*. EPSPs and IPSPs are conducted *decrementally* through the postsynaptic neuron, that is, they get weaker as they go and die out before they get very far down the axon. Their function is to influence the production of other electrochemical signals that do not die out.

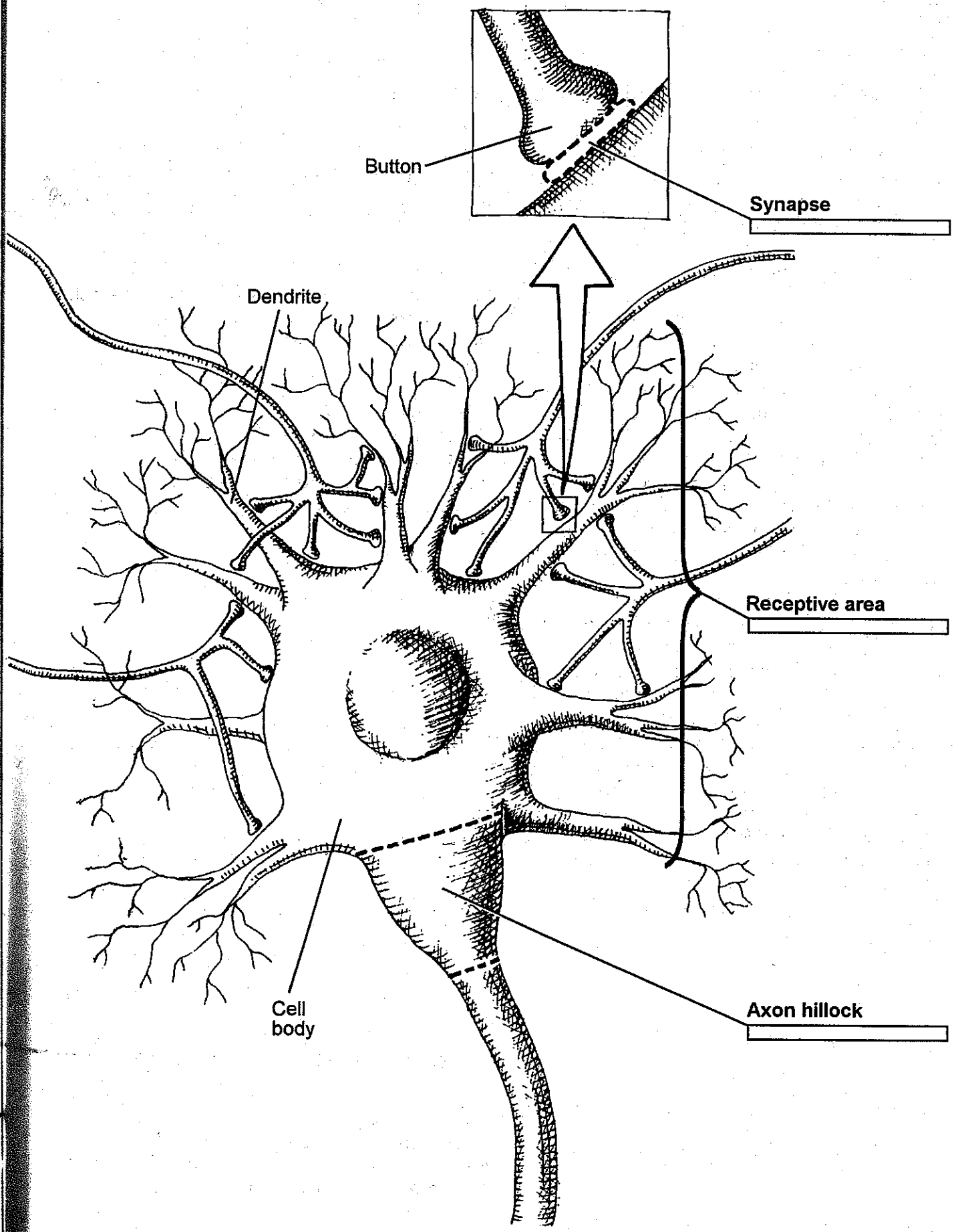
At any one time, many of the synapses on a neuron's receptive area are likely to be simultaneously active. The resulting EPSPs and/or IPSPs then travel decrementally, but instantly, to the axon hillock. The **axon hillock** is the cone-shaped region at the junction between the cell body and the axon; it is the neuron's trigger zone. The axon hillock adds together all of the EPSPs and IPSPs that are reaching it at any one time. Each time that the level of excitation at the axon hillock exceeds the amount of inhibition by a sufficient amount, an *action potential (AP)* is produced—this sufficient amount is called the *threshold of excitation*. Action potentials are then conducted down the axon to the terminal buttons.

Receptive area
The dendrites and cell body of a neuron; the area of a neuron that receives most of its synaptic input.

Synapse (SIN aps)
The narrow cleft between a terminal button of one neuron and the receptive membrane of another.

Axon hillock (HIL uk)
The cone-shaped junction between the cell body and axon; the part of the neuron that generates action potentials.

Coloring notes
First, color the synapse and axon hillock by staying within the dashed lines. Then, color the receptive area (i.e., the dendrites and cell body).


Button
Synapse
Dendrite
Receptive area
Cell body
Axon hillock

3.5 Axonal Conduction and Synaptic Transmission

Action potentials are generated at the *axon hillock* when the sum of the EPSPs and IPSPs that it receives at any given moment is sufficiently excitatory, that is, when it exceeds the *threshold of excitation.* Unlike EPSPs and IPSPs, which vary in strength, action potentials are *all-or-none* potentials, that is, they occur full blown or not at all. Through the active involvement of the axonal membrane, action potentials are conducted along the axon *nondecrementally*, that is, they do not grow weaker as they are conducted down the axon. Accordingly, each action potential is just as large when it reaches the terminal buttons as it was when it left the axon hillock.

When an action potential arrives at a terminal button, it triggers the release from the buttons of some of the *neurotransmitter molecules* that were stored in *synaptic vesicles* near the **presynaptic membrane**—the process of neurotransmitter release is called *exocytosis*. During exocytosis, the synaptic vesicles bind to the presynaptic membrane and then split open, thus releasing their contents into the synapse.

The neurotransmitter molecules travel across the synapse and bind in key-in-lock fashion to **receptors** in the **postsynaptic membrane**. There are specific receptors for each type of neurotransmitter molecule. In binding to its receptor, a neurotransmitter molecule usually induces either an EPSP or an IPSP in the postsynaptic neuron—a given synapse is either excitatory or inhibitory, not both.

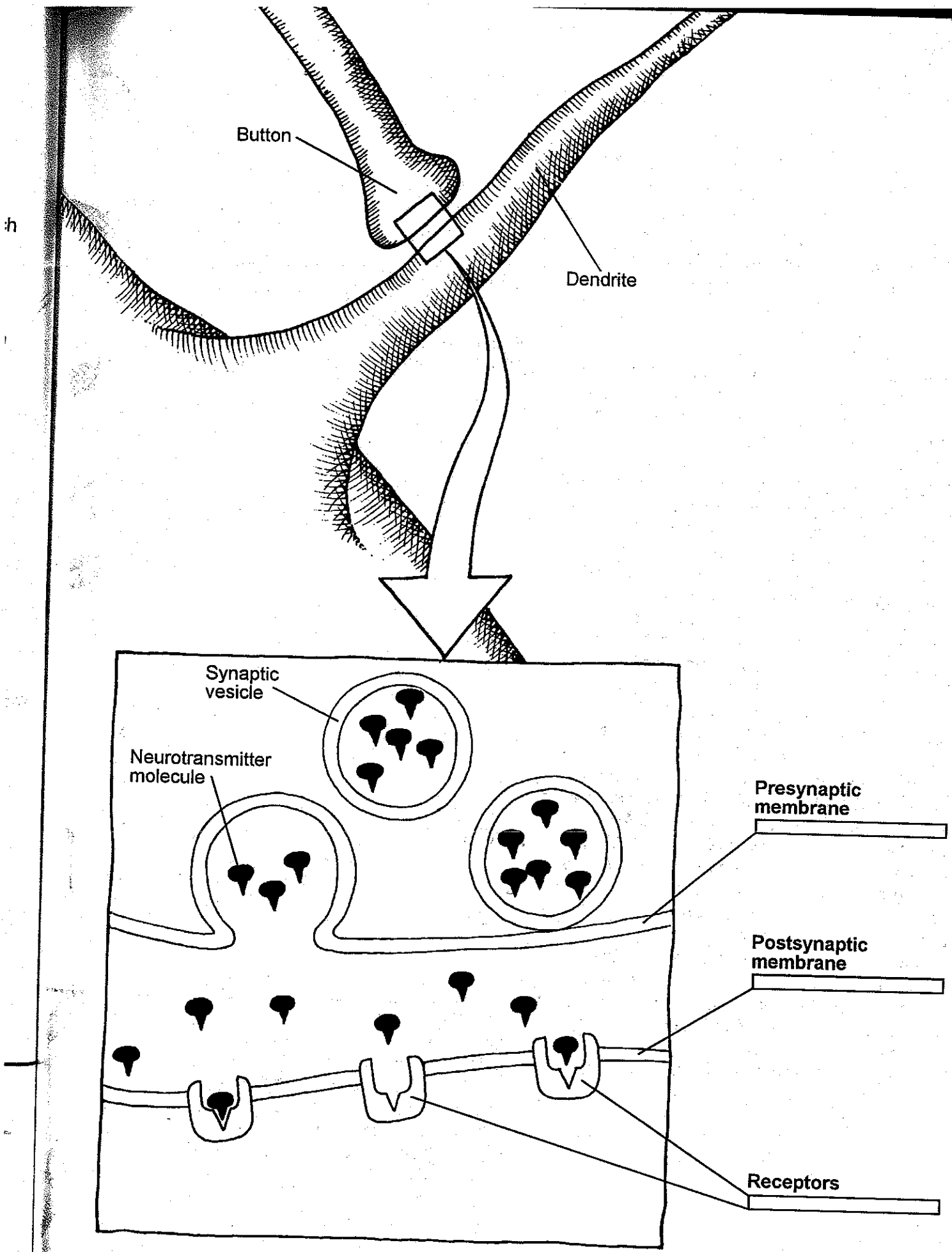
Presynaptic membrane
The section of the button membrane that is adjacent to the synaptic cleft; the site from which neurotransmitter molecules are released into a synapse.

Receptors
Molecules in the neuron cell membrane to which neurotransmitter molecules bind in key-in-lock fashion and, in so doing, induce signals in the neuron.

Postsynaptic membrane
The section of the cell membrane of a postsynaptic neuron that is adjacent to the synaptic cleft; the postsynaptic membrane contains postsynaptic receptors.

Coloring notes

First, color the presynaptic membrane, including the vesicle that is releasing its neurotransmitter molecules—once a vesicle becomes attached to the presynaptic membrane, it becomes part of it. Next, color the receptors and finally the postsynaptic membrane.


Button
Dendrite
Synaptic vesicle
Neurotransmitter molecule
Presynaptic membrane
Postsynaptic membrane
Receptors