Figure 11a: Synaptic Transmission

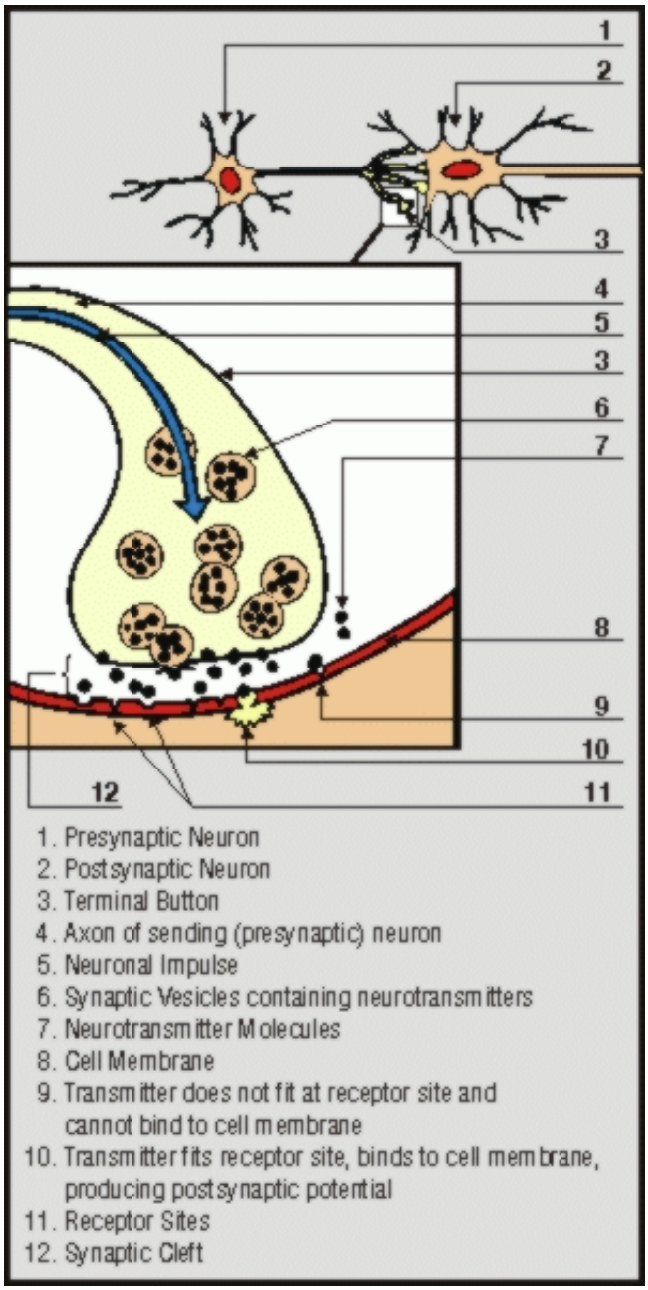

Figure 11a | Figure 11b

Presynaptic Neuron | Postsynaptic Neuron | Terminal Button | Axon | Neuronal Impulse | Synaptic Vesicles | Neurotransmitter Molecules | Cell Membrane | Transmitter does not fit | Transmitter fits | Receptor Sites | Synaptic Cleft

Part 1: Image-Mapped Tutorial
Part 2: Matching Self-Test
Part 3: Multiple-Choice Self-Test

Return to main tutorial page

Figure 11a illustrates the site where information is conveyed from one neuron to the next. At this junction, called the *synapse*, chemicals are used to transmit the electrical neuronal impulse. The structures (magnification approximately 93,000X) and substances involved in synaptic transmission at a *directed synapse* are identified, and the sequence of events in chemical transmission are described. A directed synapse is one in which the neurotransmitter release sites and receptor sites are close, but not touching. The cleft or space between these structures is typically 0.02-0.05 microns wide. A greater distance between the site of neurotransmitter release and the site of reception characterizes another type of synapse. In this so-called *non-directed synapse*, the neurotransmitters are released from variscosities (called "string-of-beads") along a neuron's axon.

Synapses occur between different neuronal structures, and are named based on the site of neurotransmitter release (presynaptic membrane) and site of receptor binding (postsynaptic membrane). The most common synapses are *axodendritic* (between axon and dendrite), *axosomatic* (between axon and soma), or *axoaxonic* (between two axons). The basic process of information exchange at axodendritic and axosomatic synapses is the primary topic of this tutorial. Axoaxonic synapses modulate neuronal transmission by either inhibiting or facilitating depolarization at the presynaptic membrane. Dendrodendritic synapses appear to be unique in their ability to transmit in either direction, allowing for reciprocal effects. The multiple modes of communication provided by the varied synaptic connections underlie the complex structure of communication in the nervous system.

Suggestions for further study

SUGGESTED READINGS:

Beardsley, T. (1999, June). Getting wired. New observations may show how neurons form

connections. *Scientific American, 280*(6), 24, 26.

Changeux, J.P. (1980, April). Chemical signaling in the brain. *Scientific American, 242*(4), 152-171.

Dunant, Y & Israel, M. (1985, April). The release of acetylcholine. *Scientific American, 252*(4), 58-66.

Dustin, P. (1980, August). Microtubules. *Scientific American, 243*(2), 66-76.

Kalil, R.E. (1989, December). Synapse formation in the developing brain. *Scientific American, 261*(6), 76-79, 82-85.

Keynes, R.D. (1979, March). Ion channels in the nerve-cell membrane. *Scientific American, 240*(3), 126-132, 134-135.

Llinas, R.R. (1982, October). Calcium in synaptic transmission. *Scientific American, 247*(4), 56-65.

Myers, C.W. & Daly, J.W. (1983). Dart-poison frogs. *Scientific American, 248*(2), 120-133.

Nathanson, J.A. & Greengard, P. (1977, August). "Second messengers" in the brain. *Scientific American, 237*(2), 109-119.

Neher, E. & Sakmann, B. (1992, March). The patch clamp technique. *Scientific American, 266*(3), 28-35.

Rennie, J. (1990, January). Nervous excitement. *Scientific American, 262*(1), 21.

Rothman, J.E. & Orci, L. (1993, November). Budding vesicles in living cells. *Scientific American, 274*(3), 70-75.

Satir, B. (1975, October). The final steps in secretion. *Scientific American, 233*(4), 29-37.

Schwartz, J.H. (1993, November). The transport of substances in nerve cells. *Scientific American, 269*(5), 58-62.

Simons, K. & Ikonen, E. (1997). Functional rafts in cell membranes. *Nature, 387*, 569-572.

Snyder, S.H. (1985, October). The molecular basis of communication between cells. *Scientific American, 253*(4), 132-141.

RELATED LINKS:

http://www.scienceweek.com/swfr051.htm
(Neurobiology: Neurotransmitter Release)
Summaries of Focus Reports from ScienceWeek

http://www.sciencedaily.com/releases/1999/07/990708080126.htm
(Protein Studies Reveal Sophisticated Control Of Nerve Communication)
Science Daily Research News

http://www.csuchico.edu/psy/BioPsych/neurotransmission.html
(Neurotransmission)
Maintained by Biopsychology at University of California at Chico

http://www.sfn.org/briefings/nmda.html

(NMDA Receptors)
from Society for Neuroscience - *Brain Briefings*, 1994.
NMDA receptor blockers and the prevention of neuronal damage due to stroke, epilepsy, Huntington's Disease, and AIDS

http://www.cnl.salk.edu/~zador/MI-final/MI-final.html
(The Impact of Synaptic Unreliability on the Information Transmitted by Spiking Neurons)
A. Zador, *Journal of Neurophysiology*, primary research paper on neural integration