

# Molecular Neurobiology for Practicing Psychiatrists, Part 1: Overview of Gene Activation by Neurotransmitters

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**Issue:** *Molecular biology is increasingly relevant to practicing psychiatrists because it helps to explain the biological basis of mental disorders and especially the molecular and pharmacologic mechanism of action of psychotropic drugs. The ultimate action of neurotransmitters and drugs that act at receptors is to alter the activity of neuronal genes.*

**T**his feature begins the first of a series of articles on molecular neurobiology for the practicing psychiatrist. Shown here is the “visual vocabulary” for each of the critical elements in the activation of neuronal genes by neurotransmitters.<sup>1</sup> Subsequent lessons will demonstrate how each element of this visual vocabulary relates to the others, resulting ultimately in the expression of genes that regulate neuronal functioning in the target neuron.

*BRAINSTORMS is a monthly section of The Journal of Clinical Psychiatry aimed at providing updates of novel concepts emerging from the neurosciences that have relevance to the practicing psychiatrist.*

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Figure 1. Neurotransmitter Receptors

Neurotransmission begins with “first messenger” neurotransmitters (such as the monoamines serotonin, norepinephrine, and dopamine) occupying their receptors (usually a member of the receptor superfamily known as 7 transmembrane region G protein–linked second messenger system), which results in activation of second messenger systems.

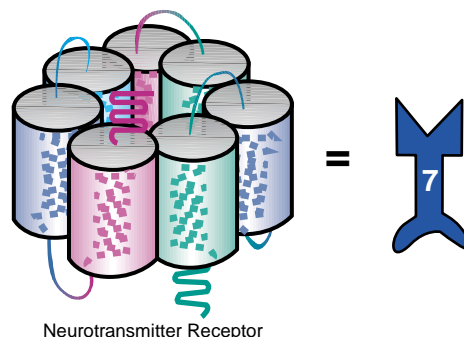


Figure 2. Enzymes

The second messengers then hand the message off to an enzyme that participates in the regulation of gene activation by changing the messenger into another form, such as transcription factors. The most important enzyme, protein kinase, phosphorylates various intracellular proteins, especially various transcription factors. Other important enzymes include dephosphatase enzymes, which reverse the phosphorylation process, and RNA polymerase, which transcribes DNA into RNA.

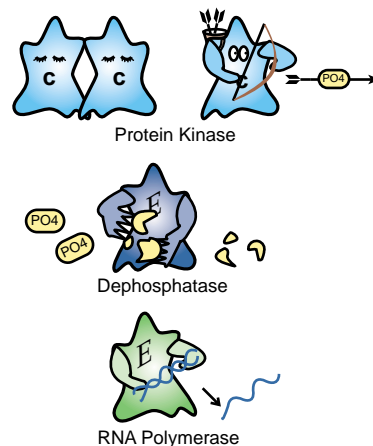
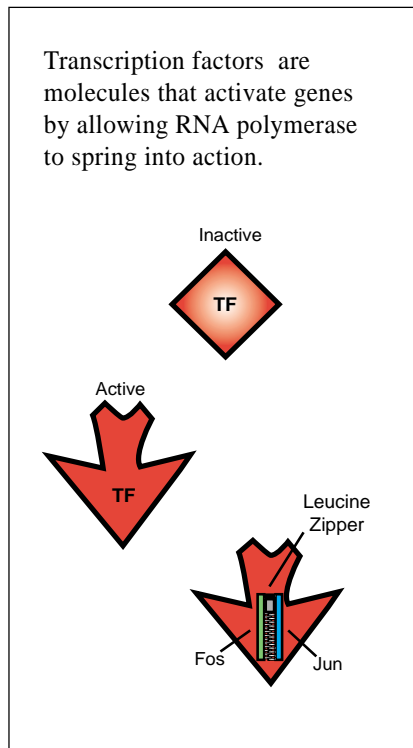


Figure 3. Transcription Factors



### Take-Home Points

- ◆ Chemical neurotransmission can be described as a cascade of biochemical events resulting in changes in the expression of genes in the target neurons.
- ◆ Molecular elements in this cascade include not only the neurotransmitter and its receptor, but also second messengers, enzymes, transcription factors, genes, and gene products.

Figure 4. Genes

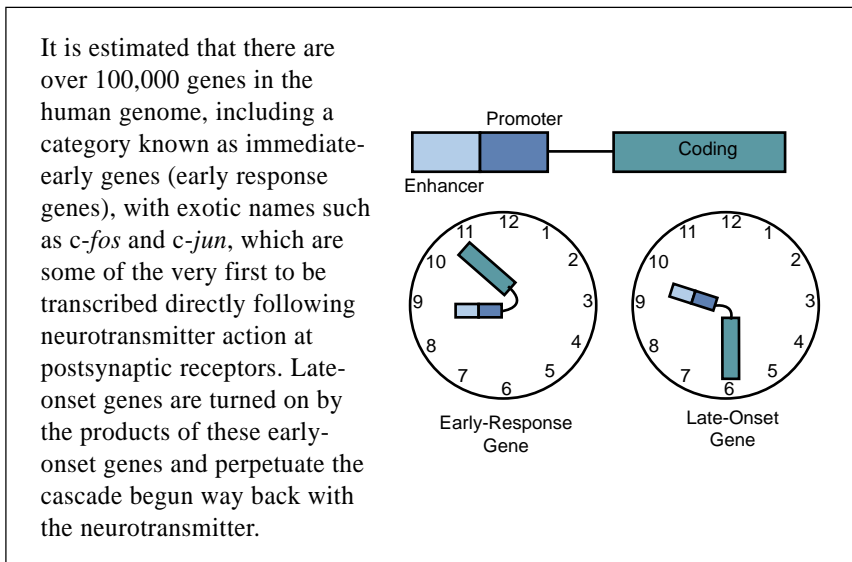
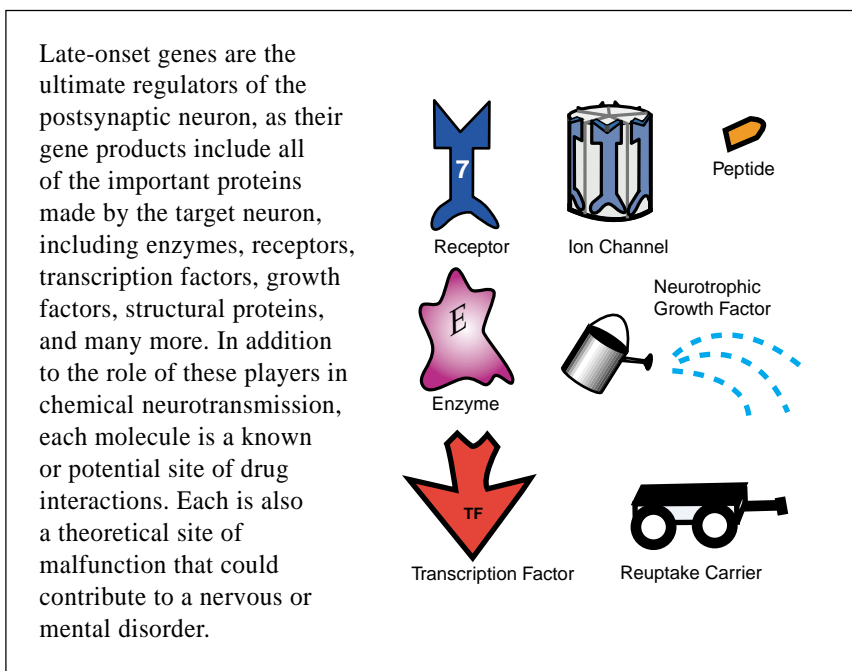


Figure 5. Gene Products



### REFERENCE

1. Stahl SM. Essential Psychopharmacology. 2nd ed. New York, NY: Cambridge University Press. In press

### Coming Next Issue

## PART 2: HOW NEUROTRANSMITTERS ACTIVATE SECOND MESSENGER SYSTEMS