



AP Bio

FRQ Fridays

2015 #7
Synaptic Signaling & Gene Expression



FRQ Friday #18

2015 #7

Smell perception in mammals involves the interactions of airborne odorant molecules from the environment with receptor proteins on the olfactory neurons in the nasal cavity. The binding of odorant molecules to the receptor proteins triggers action potentials in the olfactory neurons and results in transmission of information to the brain. Mammalian genomes typically have approximately 1,000 functional odorant-receptor genes, each encoding a unique odorant receptor.

(a) **Describe** how the signal is transmitted across the synapse from an activated olfactory sensory neuron to the interneuron that transmits the information to the brain.

Description (1 point)

- Neurotransmitters are released from the olfactory neuron and bind to receptors in the postsynaptic neuron.



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a. When an action potential reaches a synapse, it triggers the opening of gated calcium channels, and calcium flows into the synapse. Influx of calcium stimulates the formation of vesicles around neurotransmitters to perform exocytosis and release neurotransmitters in the synapse. These neurotransmitters from the sensory neuron ~~are~~ then bind to the receptors of sodium channels at the dendrites of the interneuron. This depolarizes the postsynaptic neuron's membrane because sodium rushes in, which leads to the formation of an action potential in the interneuron so it can transmit the information to the brain.



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(b) **Explain** how the expression of a limited number of odorant receptor genes can lead to the perception of thousands of odors. Use the evidence about the number of odorant receptor genes to **support** your answer.

Explanation and support (2 points maximum: points may be earned from only one row)

	Explanation (1 point)	Support (1 point)
Molecular	<ul style="list-style-type: none">• One odorant molecule can be recognized by more than one odorant receptor• One odorant receptor can bind to more than one odorant molecule	Mathematical combinations expand possible odors detected
CNS Control	Signals integrated in the brain	Multiple interactions among neurons in the brain
Genetic	Alternate processing/splicing (of pre-mRNA/primary transcript)	Multiple receptors can be produced from a gene



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b. ~~Go~~ A small number of genes can lead to the perception of thousands of odors through alternative splicing during post-transcriptional modification. Once a pre-mRNA transcript is transcribed, a spliceosome removes noncoding introns and splices together the remaining exons, but these can be put together in multiple combinations to be made into different odor receiving proteins.

