**2.** Many insects rely on pheromones (chemical signals) that are released by the females to find mating partners. Scientists hypothesize that, in a certain type of moth, the behavior of male moths in response to pheromones is regulated by the extracellular signaling molecule 20E.

**A.** Many receptors are embedded in the plasma membrane. **Describe** the polarity of the portion of the receptor that is inside the membrane.

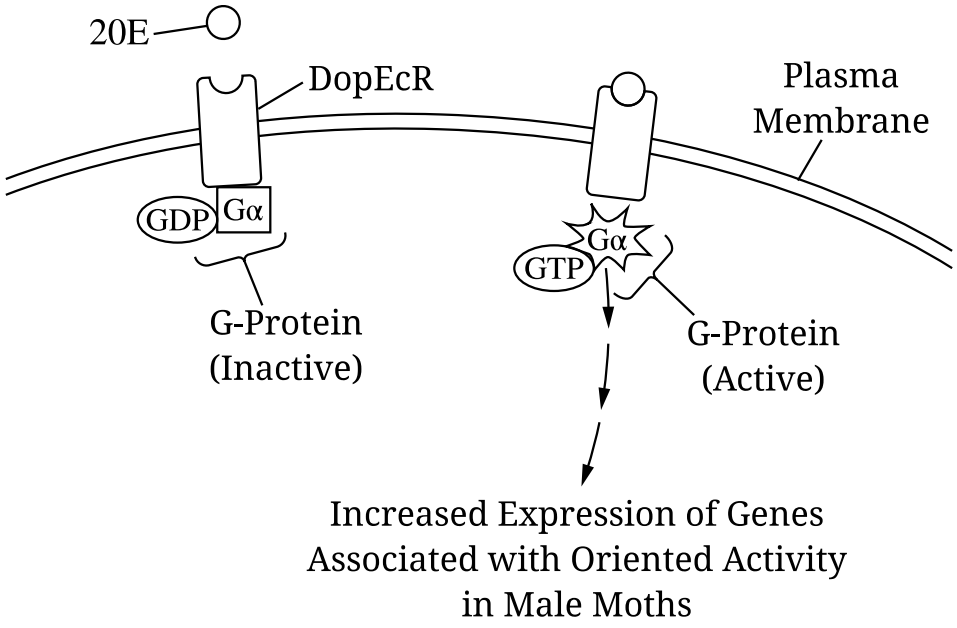
To investigate whether the binding of 20E to its receptor, DopEcR, affects behavior in moths, scientists injected male moths with saline (control solution) or with small interfering RNA molecules (siRNAs) that inhibit the expression of the gene encoding DopEcR. The scientists then exposed the moths to the pheromone and determined the percent of total time observed that the moths engaged in general activity, defined as movement in any direction. The scientists also determined the percent of the general activity time that the moths spent in oriented activity, defined as movement toward an area of high pheromone concentration (Table 1).

Table 1. Average General and Oriented Activity in Male Moths Injected With Saline or siRNA Molecules

| Treatment | General Activity (percent of total time observed, average $\pm 2SE_{\bar{x}}$) | Oriented Activity (percent of general activity, average $\pm 2SE_{\bar{x}}$) |
|---|---|---|
| Male moths injected with saline (control solution) | $95 \pm 5$ | $60 \pm 4$ |
| Male moths injected with siRNAs that inhibit expression of the gene encoding DopEcR | $90 \pm 8$ | $25 \pm 6$ |

DopEcR is a G protein-coupled receptor. When 20E binds to DopEcR, GTP displaces the GDP bound to the G protein, and a signaling pathway is activated. The scientists hypothesize that this leads to the transcription of genes associated with the oriented activity observed in the male moths (Figure 1).

**Figure 1. A simplified model of a signaling pathway activated by the binding of 20E to its receptor, DopEcR**




**B.**

i. Using the template in the space provided for your response, **construct** an appropriate type of graph that represents the data in Table 1. Your graph should be appropriately plotted and labeled.

ii. Based on the data in Table 1, **determine** the type of activity that was affected by inhibiting the expression of the DopEcR receptor.

**C.**

i. Based on Table 1, **identify** the treatment group in which the oriented activity was greater than 50% of the general activity.

ii. The scientists studied some moths with a mutation in the gene encoding the G protein. The mutation prevents GTP from displacing the GDP bound to the G protein. Based on Figure 1, **predict** the effect of this mutation on the oriented activity in male moths exposed to the pheromone.

Expression of the gene encoding DopEcR is low in the male moths during their first few days as adults, when they are sexually immature. Gene expression rapidly increases as the moths reach sexual maturity. The scientists claim that this increase in gene expression increases the likelihood of males finding females with whom to mate.

**D.**

i. Use evidence from the information provided to **support** the scientists' claim.

ii. Based on Figure 1, **explain** how an inhibitor of the DopEcR pathway might serve as an effective chemical to protect crops from moth damage.

## Question 2: Interpreting and Evaluating Experimental Results with Graphing — 9 points

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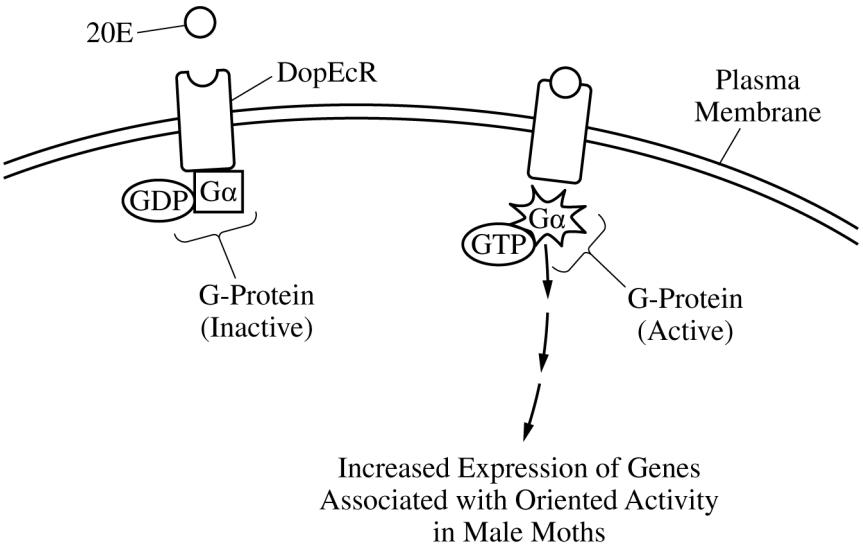


**Figure 1. A simplified model of a signaling pathway activated by the binding of 20E to its receptor, DopEcR**