AH National Qualifications 2024

X807/77/11

Biology
Supplementary sheet

WEDNESDAY, 15 MAY

9:00 AM – 12:00 NOON

Supplementary sheet for question 1

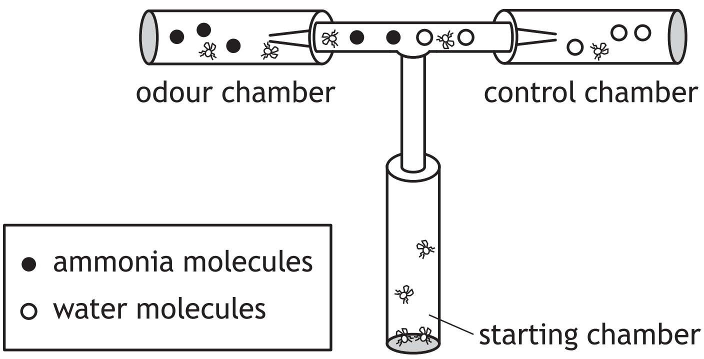
1. Olfaction (sense of smell) is an important way in which animals interact with their environment. In insects, olfaction plays a role in behaviours such as finding food or mating partners, and the avoidance of predators.

Ammonia and amines are chemicals released during the decomposition of nitrogen-containing molecules. Many species, including *Drosophila* species (fruit flies), use ammonia and amines as olfactory signals, possibly because they indicate the presence of a protein-rich food source.

Figure 1 shows a piece of apparatus called a T-maze, which was used to study the response of the fruit fly *Drosophila melanogaster* to ammonia and amines.

Flies are released into the starting chamber and allowed to choose between the odour and the control chamber. After a period of time, the number of flies in each tube is counted and a preference index (PI) calculated using the formula given.

Figure 1



$$PI(\%) = \frac{\textit{number of flies in odour chamber} - \textit{number of flies in control chamber}}{\textit{total number of flies in odour and control chambers}} \times 100$$

Table 1 shows raw data for one experiment using a T-maze to study the response of *Drosophila melanogaster* to ammonia.

Table 1

Trial number	Number of flies in odour chamber	Number of flies in control chamber
1	20	4
2	18	3
3	21	2
4	19	4
5	21	1

1. **(continued)**

Figure 2A shows how changing the ammonia concentration affected the olfactory response of *Drosophila melanogaster*. The responses of flies to a variety of amines, as well as carbon dioxide, was also studied, and the results of these experiments are shown in **Figure 2B**.

Figure 2A

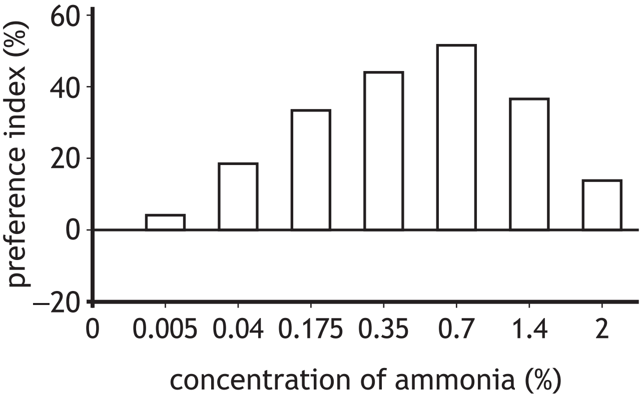
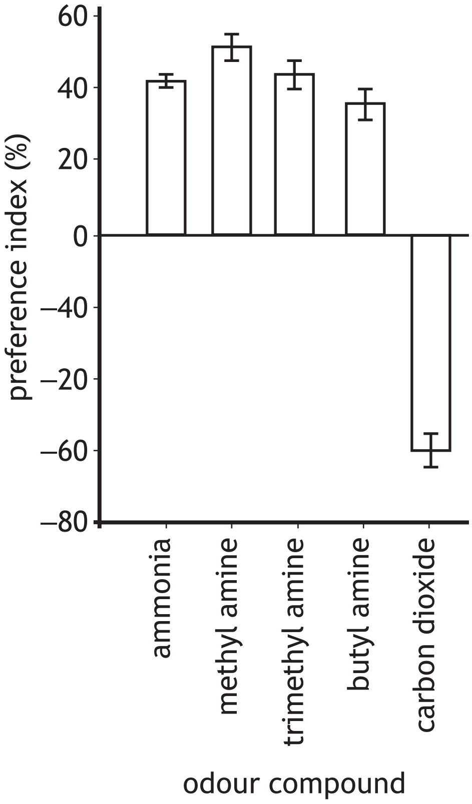
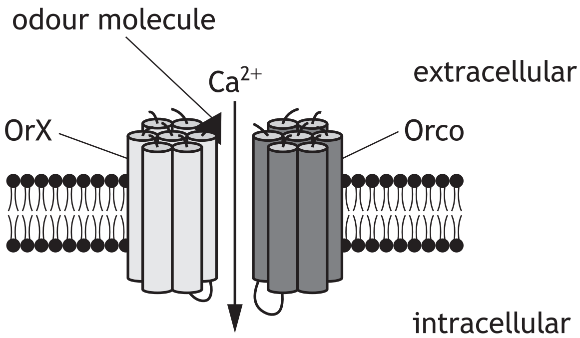


Figure 2B



Flying insects contain a type of olfactory receptor (OR) in their antennae that is not found in other organisms. Flying insect ORs are ligand-gated ion channels that allow calcium ions (Ca^{2+}) to enter cells. Insect ORs are made up of a protein that binds odour molecules (OrX) and another protein called Orco, as shown in **Figure 3**.

Figure 3



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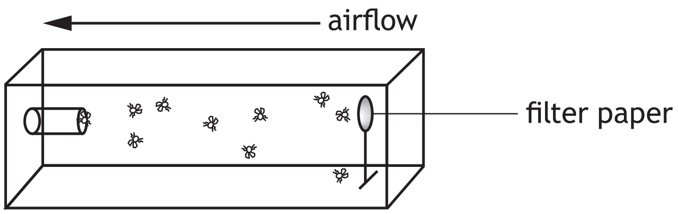
1. **(continued)**

A recent study investigated the role of an intracellular protein called calmodulin in the function of ORs in *Drosophila melanogaster*. Calmodulin acts as a Ca^{2+} sensor by binding to Ca^{2+} in the cell. This binding switches calmodulin from an inactive to an active state; active calmodulin then binds to and modifies the activity of many target proteins including Orco.

One experiment in this study used a wind tunnel assay in which grape juice was pipetted onto filter paper attached to a metal stand as shown in **Figure 4**. Flies were released into the chamber and the number of flies landing on the filter paper was counted and used to calculate a landing percentage.

Figure 4



Flies with a mutation in the calmodulin binding-site of Orco (Orco MUT) and flies lacking the Orco protein ($Orco^{-}$) were compared to Wild-type (WT) flies with normal phenotype. The results are shown in **Figure 5A**.

In a second experiment, the Ca^{2+} levels inside the cells of antennae were measured following exposure of wild-type and mutant *Drosophila* to different concentrations of grape juice. The results are shown in **Figure 5B**.

Figure 5A

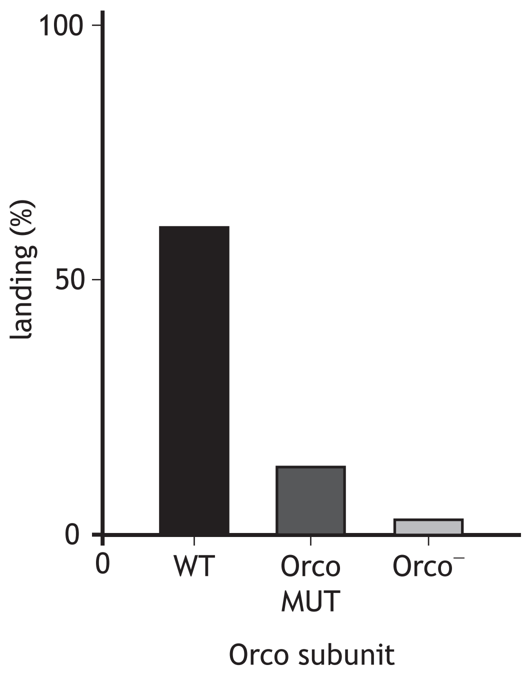
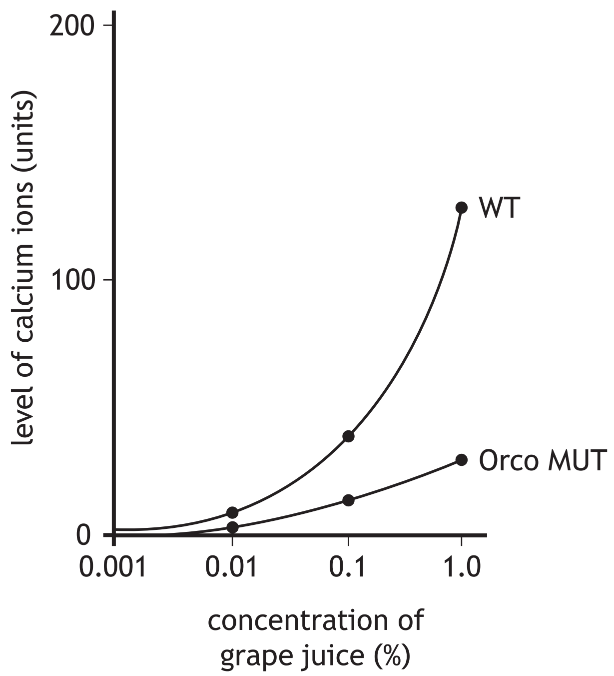


Figure 5B



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