

STUDENT GUIDE

Our Chemical Senses: Olfaction

“I can’t smell a thing!”

“Eeoooh! What’s that awful smell in here?” Ann exclaimed as she walked into the kitchen. “Smells like a skunk.” “What? I don’t smell it,” said her older sister Sarah. “Of course, I can hardly smell a thing with this cold...or taste anything either. What do you mean it smells like a skunk?” “Well, you know,” replied Kelly, “that really strong bitter smell. I can’t believe you don’t notice it. Hey! Isn’t that the smell when the pilot light goes out on the gas stove?? Oh man, we better check it!” “Here, I’ll help look,” said Sarah. “You’re right! It’s out! There, I’ve lighted it. Wow, that could be dangerous—we better tell Mom to check the stove. Good thing we don’t both have colds.”

What had happened to Sarah’s sense of smell, or olfactory sense? How is a sense of smell important to us?

How do our bodies get information from the *sense of smell*?

Through our sense of smell, we detect an enormous variety of molecules that come floating or whirling into our noses. These odors might signal something pleasant—a flower, something dangerous—smoke, or something we definitely need to eat right now—pizza! Our ability to smell things and our responses to odors are influenced by many things, including our genes, age, gender, individual experiences, what we think a particular smell might mean, and our current surroundings.

Your teacher will discuss in class the parts of the olfactory system and how they work. This system includes special **receptor nerve cells (neurons)** high inside the nose, extensions from the neurons called **axons** that form **pathways** where the messages travel to the brain, and **areas of the brain** that receive the odor messages and interpret them. After your class discussion and experiment, try to figure out what had happened to Sarah’s sense of smell.

Name: _____ Date: _____

CLASS EXPERIMENT

What's that smell?

LAB QUESTION

PREDICTIONS

SUPPLIES

- smell materials or “odorants” in containers
- timer or stopwatch
- paper for writing results

PROCEDURE

1. Write the **Lab Question** and then write your predictions in the boxes above.
2. Your teacher will **demonstrate** the safe way to smell unknown materials.
3. Follow all **safety procedures** your teacher recommends.

4. Follow your teacher's instructions for choosing **data recorder/timekeepers and subjects** for your group. Let your teacher know if you have any **allergies** or do not want to be a subject.
5. Each data recorder/timekeeper should work with one subject on the **olfactory fatigue test** (or "getting used to a smell" test). You will do the test with at least two different odor materials. Keep enough distance between subjects so that the smells don't mix.
6. The plan is to have each subject smell two (possibly more) different odor materials until he or she can no longer smell them, or can barely smell them. Your teacher will give each group the appropriate containers of odorants.
7. Place an odor container about 15 to 20 inches from the nose of the subject, who will **gently fan** the air from the container toward his or her nose, breathing normally. Try to fan slowly and **consistently**. Be sure the subject cannot identify the material by sight.
8. The timekeeper should immediately begin timing, and when the subject reports that he or she can no longer smell the substance or can barely smell it, **write down** the number of minutes and seconds that have gone by.
9. After the first test, each subject should repeat the test with a second odor. **Write down** the times for the second test.
10. Your teacher will tell you if you should continue with more odor materials.

DATA AND OBSERVATIONS

- Your teacher will ask the data recorders to write your results in a class chart on the board.
- When all results are written, each group should calculate the **average time** for olfactory fatigue for each odor material for the class. Then write the highest and the lowest values: this is the **range** of times.
- Write down how the times **varied**: were many values similar and just a few very different, or were the values all far apart from each other?
- Write down any other interesting things you noticed while doing this experiment.

ANALYSIS: THINK ABOUT IT!

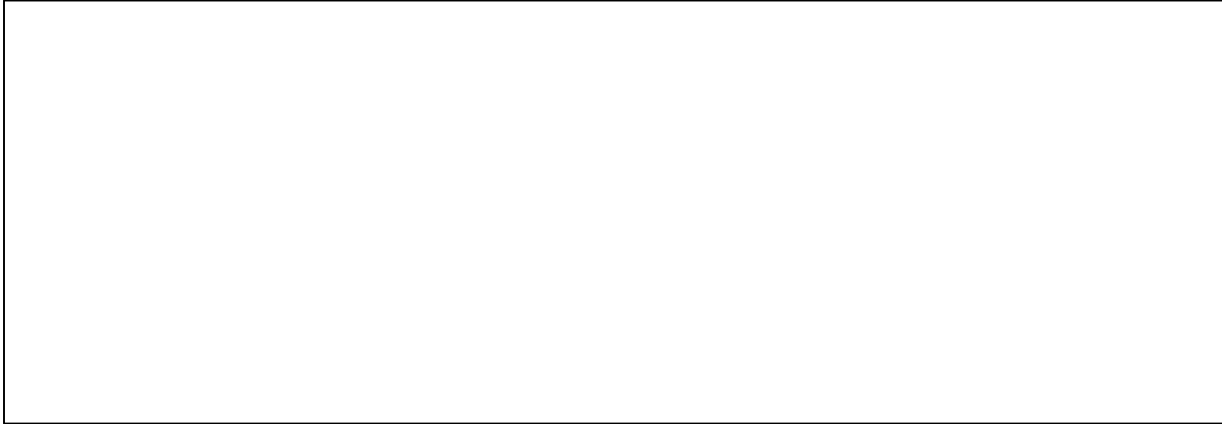
1. How do your results compare with those of other groups?

2. Were there certain odor materials that gave very different results (times) for different people, or were the results all similar?

3. What are some reasons for differences in times for olfactory fatigue?

4. Did some people seem more sensitive to smells than others? Can you think of reasons for this?

5. Draw a simple diagram showing how information from olfactory or smell receptors in the nose gets to the brain.



6. What parts of the brain receive olfactory information and are also involved in forming memories?



7. List three ways in which we use our sense of smell.



CONCLUSIONS

How was the Lab Question answered in your experiment?

List three findings you think are important from today's experiment. Were you surprised by anything you found?

How could you improve this experiment?

OUR SENSE OF SMELL

WHAT ELSE CAN WE FIND OUT ABOUT THE SENSE OF SMELL?

You can use what you have learned about the olfactory system to develop your own experiment. Brainstorm with the class or with your group to think of what you could find out if you had some containers of odor materials that a subject could smell but not see. For example, can you think of ways to **interfere** with the olfactory receptors or the nerves that send information to the smell centers in the brain? What about **odor identification**—are some people able to better identify smells than others? What would happen if you used different concentrations of the same material to test for olfactory fatigue? Memories associated with smells are often very powerful. Can you think of a way to find out about different memories associated with smells?

HOW TO DESIGN A GOOD EXPERIMENT

In designing experiments to answer questions like these, keep in mind what a successful investigator must do:

- Ask a **very specific question**: not, for example, “Can I interfere with the sense of smell?” but rather, “If I mix odor materials together, will a person be able to identify the components?” It’s good to have the general question in mind, but ask a narrow question for each experiment.
- Be sure you understand the **control condition** for your experiment, and then **change only one thing, or variable**, in the experiment.
 - ✓ For example, if you tested for differences between boys and girls, you can **define the control condition** as testing a girl. The **variable** is gender, and you would change it to a boy for your next experiment.
 - ✓ Some new experiments are themselves just control experiments. For example, if you did a matching game for your experiment, with five pairs of odor materials, that could be your control experiment. If you have time, you could add a variable in the next experiment by using four matching pairs of odor materials and an additional two that don’t match. The unmatched pair would be the variable in the new experiment.
 - ✓ Researchers try to change only one variable in a new experiment after they do a control experiment. Sometimes this is difficult, but at least they must be aware of other variables and think about what effects they might have.
- Use the Worksheet to write down your new lab question, your predictions, and the steps in your procedure. Follow the general plan of the class experiment.

TRY YOUR OWN EXPERIMENT

LAB QUESTION

PREDICTIONS

PROCEDURE

1. After you **brainstorm** ideas for your experiment, each group should agree upon and write a Lab Question in the box above.
2. **Write predictions** for the answer to your question in the box above.
3. **List the steps** you will take to perform your experiment. Include a list of supplies.
4. Figure out what the **control conditions** for your experiment will be, and whether your experiment is one that sets control conditions, or one that tests a new variable, or both.
5. Try to **change only one variable**.
6. Design a data sheet or table to **record your results**.
7. Get your **teacher's OK** before beginning your experiment.
8. **Clean up** your area when you finish.

DATA AND OBSERVATIONS

Your teacher will give you **supplies** for your new experiment.

In addition to recording data such as smells identified or times until olfactory fatigue, write down observations on what worked well and what didn't, problems with supplies, or disagreements people in the group had.

ANALYSIS: THINK ABOUT IT!

1. What is the control condition for your experiment?

2. What did you change or add for your new experiment? Did you change only one variable?

3. Did the class find any consistent gender differences, or did the differences in ability to identify smells seem to depend on individuals rather than gender? For your answer, make a table with headings of “girls” and “boys” and write the number of correct and incorrect identifications under each. **Note** that you can’t draw firm conclusions about gender differences from a small number of subjects.

	GIRLS	BOYS
CORRECT		
INCORRECT		

4. What are some reasons why the same smell can mean very different things to different people?

5. If your new experiment mixed two odor materials together, do you think they interfered with each other in the nose or in the brain? Why? Can you be sure?

CONCLUSIONS

How did your results answer your Lab Question?

How certain are you of your conclusions? Would you need more evidence to convince yourself or others that your conclusions are right?

What are some other ideas for experiments on the sense of smell?

MORE *SENSE OF SMELL* ACTIVITIES

- Do other animals smell odors the way we do? Are some animals more sensitive to smells than we are? How do aquatic animals, such as fish, smell things? What about whales? Can insects smell anything? Do some library or World Wide Web research and report to your class.
- Find out about abnormalities or diseases of the human olfactory system, using your library or the Web. Here are some words to look for:

Anosmia
Hyperosmia
Hyposmia

Here are some Web sites to get you started:

<http://www.monell.org/sensation.htm>
<http://www.monell.org/neuroscience.htm>
http://www.nih.gov/nidcd/textonly/health/pubs_st/smltaste.htm
<http://www.hhmi.org/senses>
<http://www.hhmi.org/senses/d/d110.htm>
<http://www.oslo.sintef.no/gemini/1998-01E/30.html> (Insect Olfaction)
<http://www.sfn.org/briefings/smell.html>
<http://faculty.washington.edu/chudler/nosek.html> (Neuroscience for Kids)
<http://faculty.washington.edu/chudler/chsmell.html> (Neuroscience for Kids)

- What role do smells play in advertising? Have you ever gone into a store and immediately noticed a pleasant smell? Some stores naturally have smells associated with them, such as bakeries or cosmetics stores. But others are now providing constant smells that may or may not belong to any of their products. Do you think this encourages people to buy things?
- Have you seen perfume samples in magazines? The odor is embedded in a folded piece of paper, and when you pull it open the fragrance is released. Do you think this is a more effective way of advertising than showing pictures of the perfume container or of people wearing it? Why?