BROWNIAN MOTION

TOPIC:

Molecular Movement

SCIENTIST:

Robert Brown 1773–1858

INTRODUCTION:

"Brownian motion" describes the erratic, random movements of very small particles, usually observed in liquids. It happens because as the molecules that make up the liquid move at random, they "bombard" any particles suspended in the liquid, so causing them to move. This phenomenon was first noticed by Robert Brown, one of the leading botanists of his day. In June 1827, as part of his researches, Brown was examining the pollen grains of a plant called *Clarkia pulchella*. When he looked through his microscope, Brown noticed that the pollen was moving around irregularly. At first he thought the movement might have been caused by water currents, but the water was quite still and, anyway, the grains were moving in different directions. He suggested the erratic movement might be because the pollen grains were "alive." He checked this theory by repeating the experiment with finely ground particles from nonliving sources, such as coal or glass. These particles moved in exactly the same way. Brown published his results in 1828 but he could not offer an explanation for the movement of these small particles. It remained for others to carry his work further and explain that the movement of the particles was due to the impact of moving water molecules. Eighty years after Brown's discovery, however, scientists used the phenomenon of Brownian motion as part of their final proof for the existence of atoms.

TIME NEEDED:

30 minutes

MATERIALS:

- microscope
- 2 cavity microscope slides
- 2 bottle tops
- toothpick
- flower that produces abundant pollen (such as a lily)
- pencil (no. 2)
- small, sharp knife
- eyedropper
- cup of water
- metric ruler

Original Materials:

Brown conducted this experiment with many different types of pollen (including some samples more than 100 years old), as well as with finely ground coal and glass.

Safety Precautions

Please read and copy the safety precautions at the beginning of this book. Be careful when using the knife.

PROCEDURE:

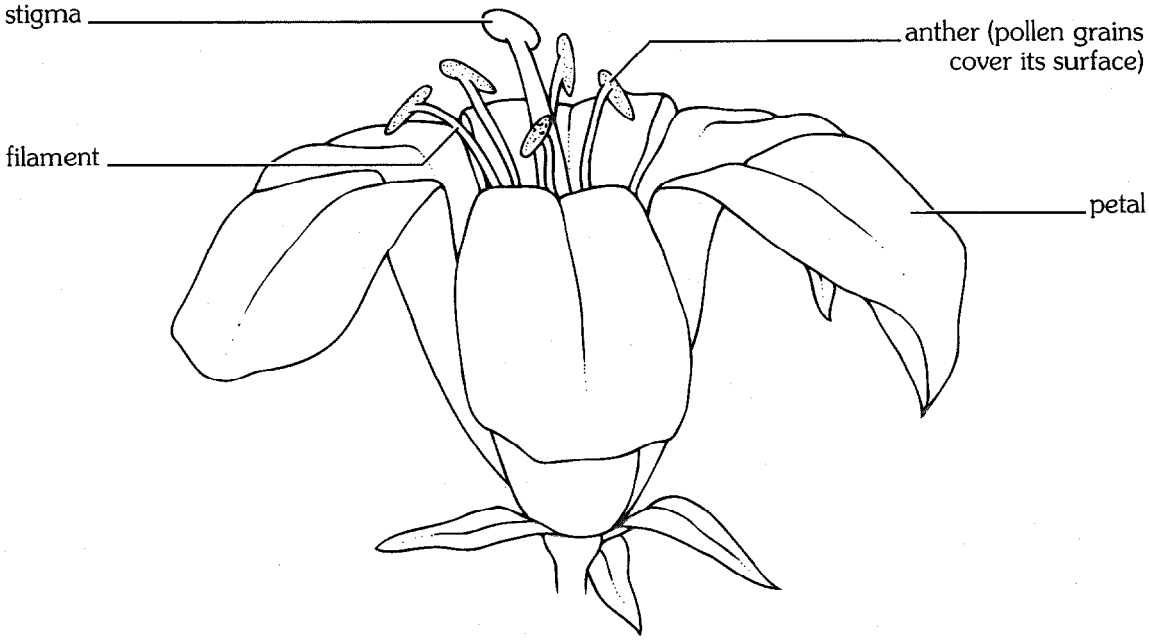
1. Look at the inside of the flower and find the anthers (see figure 1).
2. Turn a bottle top upside down. Use the toothpick to carefully scrape pollen grains from two or three anthers and deposit them inside the bottle top.
3. Fill the bottle top with water to within 5 mm of the top. Stir the pollen grain suspension using the toothpick.

4. Put the end of the eyedropper into the pollen grain suspension. Squeeze the bulb of the dropper a few times, drawing the suspension into the dropper and then releasing it, so mixing the suspension thoroughly. Then use the dropper to remove a sample from the bottle top and add a few drops to a cavity slide.

5. Put the slide on the microscope stage. Leave it for one minute to settle.

6. Look at the slide carefully under low power, looking for movement of the pollen grains. Record your observations.

Figure 1



7. Take the pencil and shave fine graphite particles from its lead using the knife. Deposit the particles inside the second bottle top.

8. Clean the eyedropper by rinsing it with water several times.

9. Repeat steps 3 to 6 using the graphite suspension, stirring the suspension in the bottle top with the end of the knife, and using the other cavity slide.

ANALYSIS:

1. Describe what you observed when you looked at the pollen grains in water under the microscope.

2. Describe what you saw when you looked at the fine graphite particles under the microscope. Did they "behave" any differently than the pollen grains?

3. Do some research. What is the modern interpretation of the movement that Brown observed?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO EXPERIMENTERS

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one experiment at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Don't use your mouth to pipette; use a suction bulb
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not use reflected sunlight to illuminate your microscope
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES