WHAT'S IN OUR AIR?

3-5 Curriculum & Activites

Air Quality Education

Three Activities and Videos

A product of the N.C. Air Awareness

NORTH CAROLINA Department of Environmental Quality

www.NCAIR.org

MISSION

NC Division of Air Quality

The Division of Air Quality (DAQ) works with the state's citizens to protect and improve outdoor, or ambient, air quality in North Carolina for the health, benefit and economic well-being of all. To carry out this mission, the DAQ operates a statewide air quality monitoring network to measure the level of pollutants in the outdoor air, develops and implements plans to meet future air quality initiatives, assures compliance with air quality rules, and educates, informs and assists the public with regard to air quality issues.

NC Air Awareness

NC Air Awareness is a DAQ public outreach and education program which has reached thousands of citizens each year, since 1997. Local Air Awareness Coordinators stratigically located in six large metropolitan areas provide outreach and education to students and the general public and work with businesses and organizations to teach them about ways to reduce their contribution to air pollution and to protect their health.

DEQ
NORTH CAROLINA
Department of Environmental Quality

Grades 3-5

What's in Our Air?

SUMMARY

In this set of short and easy activities, students will have the opportunity to learn about airborne particulate matter and how our respiratory system filters and expels them in a fun way. Students will also learn to simulate particle sampling instruments by designing simple paper particle samplers.

Time Needed

Activity 1: 20 minutes
Activity 2: 20 minutes
Activity 3: two - 45 minute time periods-approximately 2 class periods
(Sample collection : 1 week)

ESSENTIAL QUESTIONS

- What effect does particulate matter have on people and the environment?
- Why do we need to measure what is in the air?
- How can we determine the quantity and type of particulate matter present in the air around the school?

ESSENTIAL STANDARDS

Target Grade Levels:

Grade 3	*Grade 4*	*Grade 5*
3.P.2.1, 3.L.1	4.PCH.2.1	5.L.1

A description of N.C. Essential Standards and clarifying objectives, related to this lesson plan, are located at end of this document.

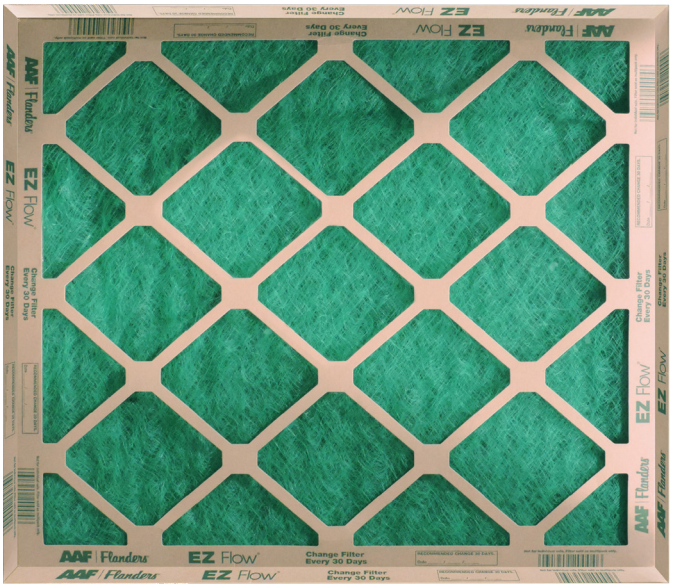
MAKING CONNECTIONS

Some particles are too small to be seen, but can be detected by other means. Scientists and engineers design instruments that trap particles suspended in the air so they can identify and study the types of particles. Many of these particles are so small that they cannot be viewed with the naked eye and must be seen with a microscope. Larger particles that students may be familiar with and can be seen are dust, pollen, leaves, and smoke. The activities contained in this lesson will give students a better understanding of particle pollution, what it is made of, variation of particles by location and how to measure particles in the air.

Coffee Filters

Magnifying glass

Pollen Viewed Under a Microscope



Home Heating and Air Conditioning Filters

BACKGROUND

What is particulate matter and how does it enter our body?

"Particulate matter," also known as particle pollution or PM, is not just dust. Particulate matter is the term for the mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using a powerful electron microscope. PM has many components including dirt, mold, pollen, soot, smoke, metals, droplets of acids, and organic chemicals. Complex chemical reactions occur in the air as chemicals, water vapor, and PM mix. Some PM occurs naturally from while some occurs due to human activity such as farming, driving vehicles, burning fuel for energy and other industrial processes.

The Environmental Protection Agency (EPA) groups particle pollution into two categories by size. They are so small that they are measured in micrometers. A micrometer, sometimes called a micron, is 1/1,000,000 of a meter.

- "Inhalable coarse particles," are between 2.5 microns and 10 microns in diameter. (PM_{10})
- "Fine particles," are 2.5 microns in diameter and smaller. ($PM_{2.5}$)

How small is particulate matter? By comparison purposes, fine beach sand is about 90 microns in diameter, and a human hair is between 50 and 70 microns in diameter. The diagram shows how particulate matter measures up.

The amount of PM in the air on a given day varies depending on the amount of human activities, the location, the season, the weather and other factors. For example, there is less particulate matter in the air after it rains.

In North Carolina, levels of PM are higher during wildfire events and/or during the winter when people burn wood for heat.

Diagram comparing the size of Particulate Matter to a human hair [1]

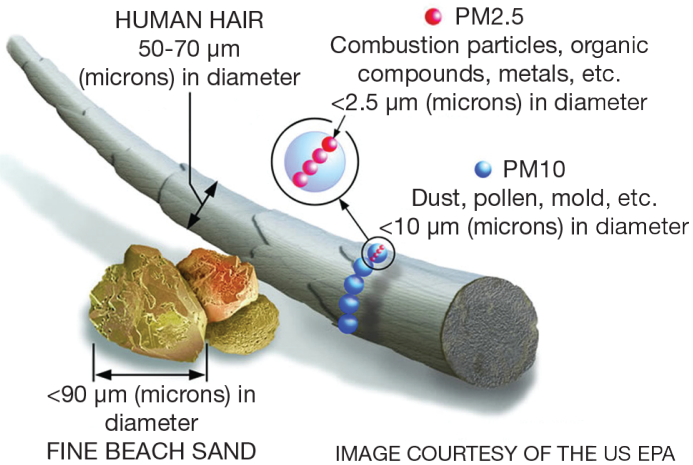


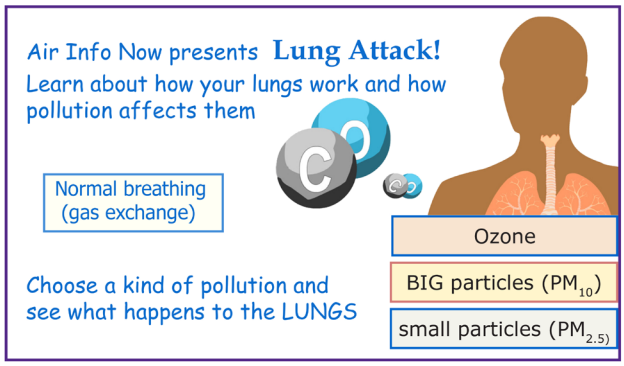
IMAGE COURTESY OF THE US EPA

[1] What is PM? https://www3.epa.gov/region1/airquality/pm-what-is.html

[2] http://www.epa.gov/pm/graphics/pm2_5_graphic_lg.jpg

Air pollution and your health

The size of particles is directly linked to their potential for causing health problems and harm to ecosystems. The World Health Organization, as well the EPA, note that the most health-damaging particles are those with a diameter of 10 micrometers (μm) or smaller. A micrometer, sometimes called a micron, is 1/1,000,000 of a meter. These small particles are generally able to pass through the nose and throat and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.



DEQ, Pima County, AZ: *Lung Attack* http://web1.pima.gov/deq/lungattack/lungplay.htm

Large particles (greater than 10 microns) are generally filtered by nose and throat hairs, called cilia, and expelled out of the body through coughing and sneezing. The body's filters may not work on particles smaller than 10 microns, allowing them to pass through the nose and throat and be deposited in the lungs. Particles smaller than ($PM_{2.5}$) microns may penetrate our bodies even further, reaching tiny air sacs in the lung called alveoli, where gas-blood exchanges occur. Fine particulate matter, is a pollutant of concern because once inhaled it can negatively affect the heart, blood vessels, and lungs. Studies show that people exposed to fine particles over a long period of time can have a higher risk of heart and/or lung diseases.

Many scientific studies have shown that exposure to $PM_{2.5}$ is associated with an increased frequency of childhood illnesses and reduced lung function. Children have a high physiological vulnerability to air pollution because they have narrow airways and their lungs are still developing. Lung irritation caused by air pollutants that would produce only a slight response in a healthy adult can result in a potentially harmful effect on a young child. There are also scientific studies that connect respiratory conditions in adults and elderly to exposure to high PM levels.

For more information about particle pollution and your health see:
http://www3.epa.gov/airnow/particle/pm-color.pdf

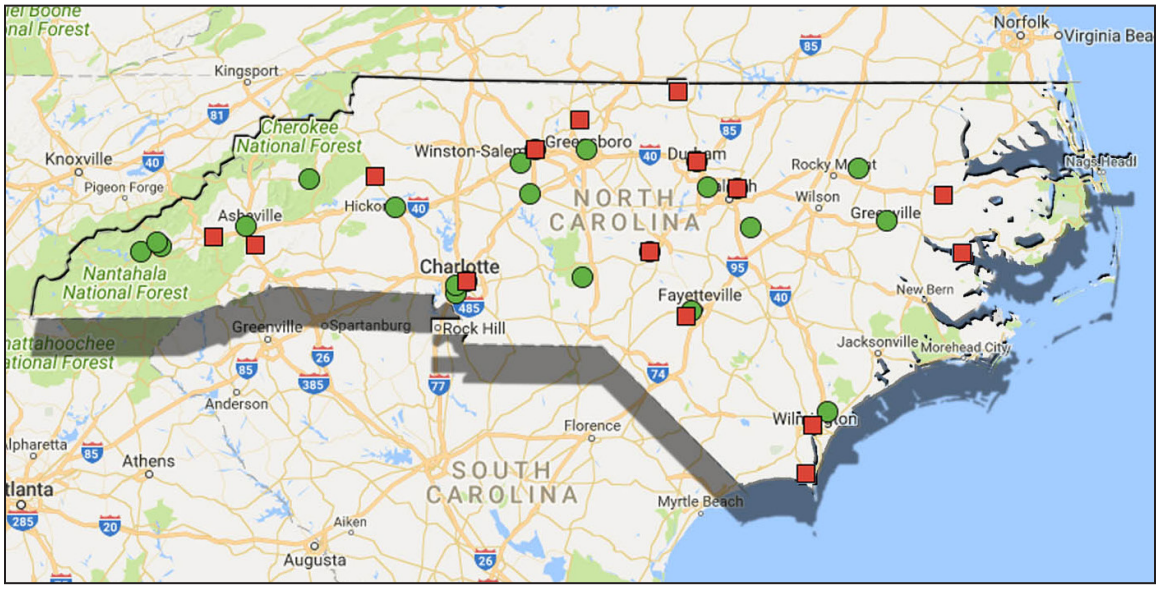
Why does North Carolina measure particle pollution?

In the early 1970s, the EPA listed six major air pollutants that affected the quality of ambient air and established concentration limits for these pollutants. Particulate matter is one of these six major, or criteria, pollutants. These limits are known as the National Ambient Air Quality Standards (NAAQS). States monitor air quality, including PM, to find out how much air pollution is in the air and to ensure that pollutant levels are meeting health-based NAAQS. Accurate data on particle measurement is essential to ensure that public health standards are maintained.

How does N.C. DAQ measure particle pollution?

N.C. DAQ operates a statewide air quality monitoring network where instruments, known as micro balancers and BAMs (Beta Attenuation Mass Monitors), collect particles suspended in the air. These instruments pass a sample of air between a light source and a light detector. The detector senses how much of that light is being blocked by the particles. The instrument collects the air sample and measures the particles continuously and sends the data to a computer to be recorded. This measurement method is both fast and accurate. To verify the instrument is measuring PM accurately, the division has a second measurement device called a weight difference sampler. This sampler uses a filter to collect PM from the air. The filters are weighed both before and after sampling and the difference in the weight gives the mass of PM in micrograms per cubic meter of air. Several key elements such as particle sampler location, collection methods, and sample handling are important in collecting accurate PM data.

N.C. DAQ determines where to place the particle samplers across our state based on population and sources of pollution. These locations are called "monitoring sites". Multiple air pollutants along with meteorological data are measured at each site. This map shows the location of the sites across the state.



For more information about N.C. DAQ air monitoring sites, their location, and pollutants sampled at each site visit: https://www.google.com/maps/d/viewer?mid=120JNXp8lGxKO5aPZxv0HsZrZ5bQ&ll=35.72712461620244%2C-81.74753433593758&z=7

The N.C. DAQ publishes the air pollution data that is collected from the monitoring sites and analyzed daily on the N.C. DAQ web page. You can find the data report at http://deq.nc.gov/about/divisions/air-quality/air-quality-monitoring.

How do you know how good or bad the air quality is each day?

The state-level monitoring data is reported daily using the Air Quality Index (AQI)[3]. The AQI is an EPA color code tool used to tell you how clean or polluted the air in your area is and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. The simplest way to know how good or bad the air quality is for the day and what it's predicted to be the next day is to check the air quality forecast. The EPA uses the AQI to quickly and easy inform the public about their local air quality. The air quality forecast index is shown below.

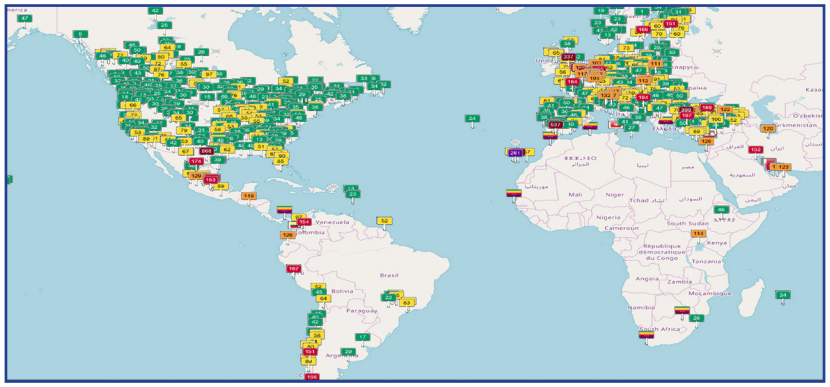
EPA Air Quality Index

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

At the worldwide level, the World Health Organization[4] establishes health-based guidelines for air quality. Many countries have adopted color-coded indices similar to EPA's to inform the public about high air pollution levels. In some large cities like London, Mexico City, or Beijing, the air quality is closely monitored because high air pollution levels can result in serious health problems city-wide. Despite knowing the adverse health effects of air pollution, many countries still don't monitor air quality. The map below shows the average level of air pollution in countries with air pollution monitoring systems. Many places including parts of Central Asia, Africa, and South America, struggle with poor air quality as indicated by the red, purple, and maroon colors.

Air Pollution in the World:

Real-time Air Quality Index Visual Map



Map of AQ levels all over the world [5]

[3] http://airnow.gov/index.cfm?action=aqibasics.aqi

[4] http://www.who.int/topics/air_pollution/en/

[5] http://aqicn.org/map/world/

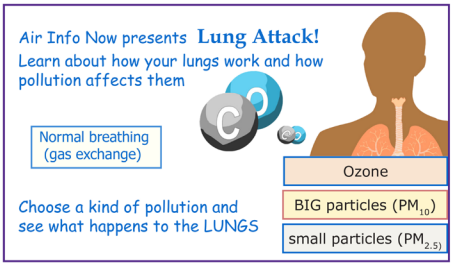
MATERIALS

- Poster board/cardboard
- Scissors
- Ruler
- Clear tape
- Transparency film/paper
- Petroleum jelly
- String or yarn
- Magnifying glasses and/or microscope
- Hole punch
- Permanent marker
- Bottle caps
- Journal
- Used newspaper or scrap paper
- Flashlight

VIDEOS

VIDEOS and POSTERS

- EPA lung diagram, Effects of Common Air Pollutants [6]
- DEQ, Pima County, AZ: http://web1.pima.gov/deq/lungattack/lungplay.htm *Lung Attack* [7]
- It's Our Air, Forecasting Air Quality Video [8]
- YouTube: Kirsten Dirksen, Monitor your air quality using an Arduino-Android DIY sensor [9]
- YouTube: RGKleid, Nephelometer video1 [10]
- YouTube: Discover particles floating in the air.



DEQ, Pima County, AZ: *Lung Attack*
http://web1.pima.gov/deq/lungattack/lungplay.htm

It's Our Air, Forecasting Air Quality Video

[5] http://aqicn.org/map/world/

[6] Effects of Common Air Pollutants, EPA. http://epa.gov

[7] Lung Attack. http://web1.pima.gov/deq/lungattack/lungplay.htm

TEACHER TIPS

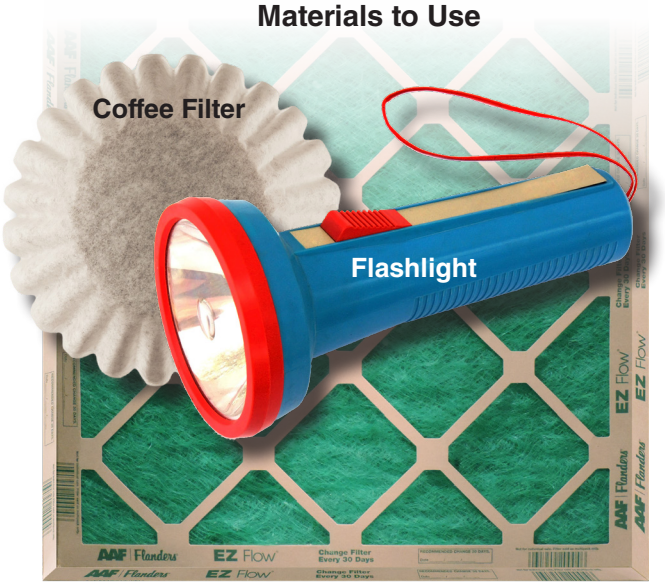
- Remind students that some of the particulate matter collected will be visible to the naked eye or magnifying glass, but a stereoscope or microscope may be needed to see some particles that are very fine or tiny.
- Remind students that even though the particles they see on their samplers seem relatively small, $PM_{2.5}$ is much, much smaller. Share a size comparison chart with your students to explain the relative size differences of particles.
- Use enlarged images of dust, dust mites, mold, and soot to give the students a visual representation of what they may find as they are looking under the microscope or in lieu of using one.
- Please check the weather forecast for wind, rain or snow and plan accordingly before setting air strip samplers outside.
- Use golf balls, coffee grains, used coffee grounds, and sand to give a better understanding of differences in particles sizes between coarse particles and fine particles.
- Have the students use a journal or weather log so students will start to understand the importance of recording scientific information.

WARM UP

Start the activity by asking students to define air pollution, particle matter pollution, and its health effects. Ask the students how we know air pollution exists. Are air pollutants visible, invisible, or both? Ask students to give examples of air pollutants from both natural sources and those from combustion of fuel and industry (e.g. fires, farm dust, smog, exhaust from cars). Make a list of their answers on the board.

Show students common examples of air particle collectors and filters (e.g. home heating/AC air filters, car air filters, or a coffee filter). Showing them dirty filters will allow them to see the PM collected. Explain to the students that the dirt and particles found in the filter are called particulate matter or particle pollution.

Materials to Use



Home Heating and Air Conditioning Filter

[8] https://vimeo.com/129567885

[9] https://www.youtube.com/watch?v=aYGzRV-W3ec

[10] https://www.youtube.com/watch?v=beEh4kE66vM

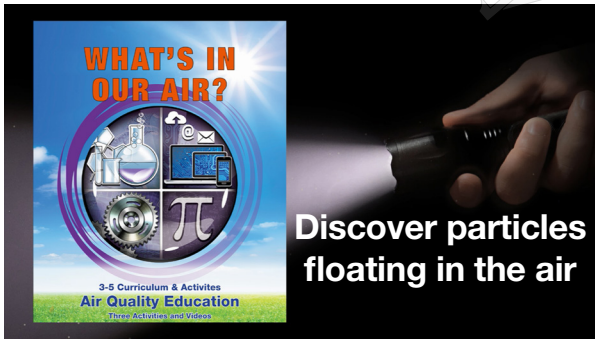
ACTIVITIES

Activity 1. Discover particles floating in the air

VIDEOS

Using a flashlight, students will discover particles suspended in the air.

We can see dust or pollen particles floating around us, but we don't always realize that this is air pollution. This simple activity gives students a visual aid of particle pollution suspended in the air.



https://youtu.be/3TdabgbiojU

1. Explain that this activity is going to be performed with the lights off. Ask the students to keep calm and pay attention to the instructions.
2. Close the window blinds and doors, and turn off the lights. Using a flashlight show the students how particles in the air show up in the flashlight beam.
3. With the light still off, ask a student to shake the blinds or a duster, or to spray a mist of water into the air.
4. Turn on the lights and ask the students to open their journals and make drawings and descriptions of what they saw.
5. Take this time to explain what particle pollution is, how it travels in the air, and how it enters our lungs.

Activity 2. How our body filters the particles suspended in the air

Students will enjoy a game designed to simulate how our body filters out air particles. During the game, students will learn the definition of air particles (coarse and fine) and cilia. The tiny nasal hairs and cilia are part of our respiratory system and serve as filters that remove many particles before they enter into our lungs. Using balls made from paper or newspaper, students will play a game designed to give them a visual representation of how our bodies filter out air particles through our respiratory system.

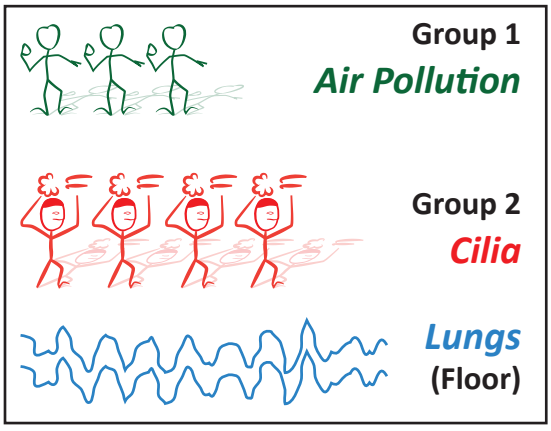
Using newspaper or scrap paper make balls of different sizes, from baseball to marble size.

1. Make 25-35 paper balls

Using newspaper or scrap paper make balls of different sizes, from baseball to marble size. Baseball-sized wads will represent the coarse particles and marble-sized wads will represent fine particles. Assign half the class to make coarse particles and half to make fine particles. We recommend using thicker paper to provide weight and texture.

2. Divide the class into two groups

Group 1 (of 3 to 5 students) will be the "air pollution group", Group 2 (rest of the class) will be the respiratory system's "cilia group", and the floor behind Group 2 will be the "lungs". Mark the area that will represent the lungs. We recommend playing this game in an area where the paper balls can be collected easily. Advise Group1 that they will throw the "particulate pollutants" to Group 2. Group 2 will act as cilia by waving their arms and trying to block (not catch) the particles and their responsibility is to defend the lungs from the particles. Any paper balls that make it past the hands of the Group 2 will have "passed into the lungs".



Group 1 (of 3 to 5 students) will be the "air pollution group", Group 2 (rest of the class) will be the respiratory system's "cilia group", and the floor behind Group 2 will be the "lungs".

3. Practice

Let the cilia group practice waving their arms back and forth to deflect the paper balls, while the air pollution group tries to throw their balls into the lungs. Remind the groups that they are not trying to "win" but trying to imitate air pollution reaching the lungs. So, the air pollution group should try to throw the balls directly into the arms of cilia group, while they wave their arms. Repeat the game multiple times rotating student roles.

4. Simulate particle pollution entering the body

a. Coarse particles
Give the air pollution group the large crumpled paper balls and instruct them to throw them at the waving arms of cilia group. Count the number of coarse particles that made it to the lungs behind the cilia. Ask the cilia group how easy or difficult it was protecting the lungs from the coarse particle air.

b. Fine particles
Tell the cilia group that they will now protect the lungs from fine particles of air pollution. Give the air pollution group the marble-size paper wads. Once again, tell the cilia group to wave their arms to defend the lungs. Count the number of fine particles that made it to the lungs. Ask them if this task was easier or more difficult to accomplish. Then ask if cilia can protect the lungs better from coarse particles or fine particles.

c. Coarse and fine particles together

Collect all the paper wads and switch roles and repeat the game. In this session, air pollution group will throw both ball sizes at the same time and count the number of coarse and fine balls that reach the lungs.

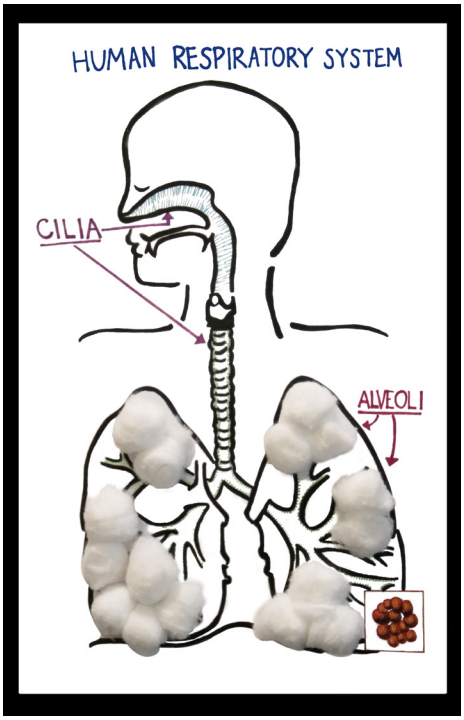
5. Extension: Analyze Data

This could be a good time to calculate fractions.

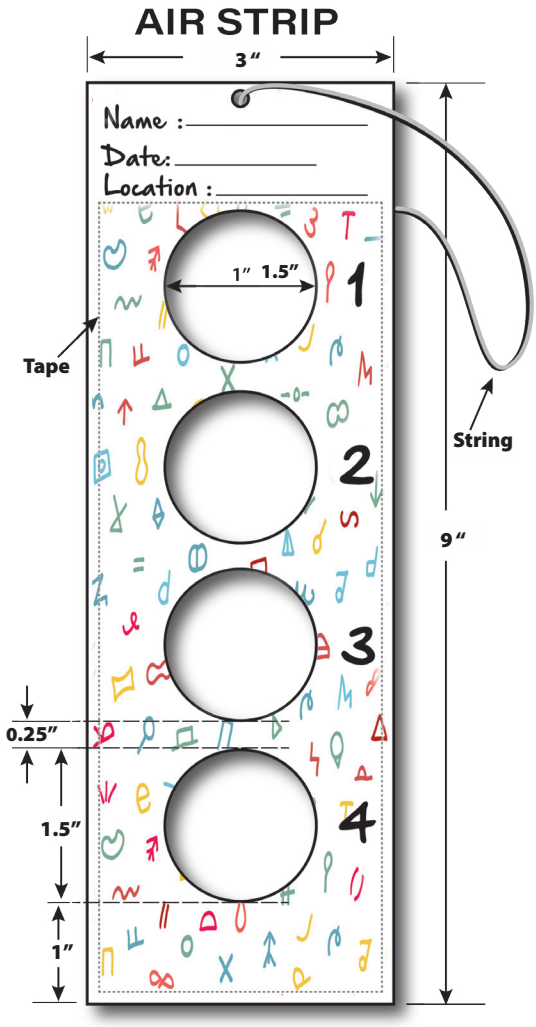
a. Let the students count the total of balls, coarse and fine that reached the lung line or area.

***Example:** Coarse: 3 of 25; 3/25*
Fine: 10 of 25; 10/25

b. Discuss why small particles can reach the lungs more easily than larger particles. Refresh and reinforce the terms air pollution, particles, cilia and alveoli and the role of those in our respiratory system.



Human Respiratory System



Activity 3. Particulate Samplers

In this activity, students will learn how to build an air particle sampler using a paper strip. They will then place it at different locations around their school to collect samples of PM and learn how location and weather conditions can affect the number of particles collected.

The goals of this activity are:

- Compare sizes and type of particles found in the air, and make connections to how PM gets into our lungs.
- Hypothesize about locations around the school that might have the greatest amount of particulate matter in the air.
- See how collected particulate matter changes in relation to time and weather.
- Understand what "collecting a sample" means.

Teacher tips:

- Paper strips should be labeled with the date, location, and student's or group's name.
- Set a control strip in your classroom to compare results.
- Advise school administration, other teachers, and custodians of your experiment so that the samplers will not be disturbed.

1. Construction of an Air Sampler

Show the students a sample of a finished air particle sampler just to give them the idea of what it looks like.

Step 1. Making the holes

a. Provide the materials to make the strips and let the teams explore their own sampler building ideas. Students can use cardboard, poster board or any recyclable materials to construct their samplers.

b. Use a bottle cap to mark the circles on a paper strip. Cut out inside edges of the marked circles to create an open hole. Be sure the diameter of all the holes is similar in size. If you have a large 1-inch diameter hole punch this can make the construction much easier.

c. Identify each hole with a number or day of the week.

Step 2. Punch a hole at the top of the paper strip and tie a string to it to hang it.

Step 3. Preparing the sticky area

a. Using transparent tape or paper cover the back of the paper strip to make the other side of the paper the sampling area to catch particles. If you are using transparent paper a thin coating of petroleum jelly on clear paper can be used.

b. After putting the transparent tape or paper on the back of the strip, cover the other holes with bottle caps or another removable cover, leaving one uncovered hole for the first day of sampling. Make sure the covers do not touch the sticky material.

2. Planning for locations

a. Discuss the importance of where to place the sampler around the school. Ask the students how the location of the sampler may affect the outcome of their study. Ask the students to predict which sampler will catch the most particles. Brainstorm with the students about what locations around the school might be interesting and work with the students to have them write a statement explaining their predictions in comparison to the control sampler of the classroom. Write the student's responses on the white board.

Teacher Tip:

1. Make sure that the samplers placed outside are covered in case of rain or check the weather to make sure that no rain is in the forecast so that the sampler isn't ruined.
2. Control sampler: keep a sampler in the classroom to compare to the other samplers.
3. Use students sheet for reference particle studies.

b. Students can develop a simple school map and make a mark on the map for where they are going to locate their samplers.

c. Be sure to put the samplers near areas where air comes in and out of the school, such as air conditioner intakes and doorways as well as areas that could have possible high levels of pollution such as parking lots.

d. Check that all samplers have been carefully labeled with the date, location, and student or team name.

e. Have the teams hang the samplers at the locations that they selected. Make sure the sampler string is tied or attached securely to prevent the sampler from falling and contaminating the sticky surfaces. Be sure the samplers are hung in places where they will not bump other surfaces to avoid particulate loss or sample contamination.

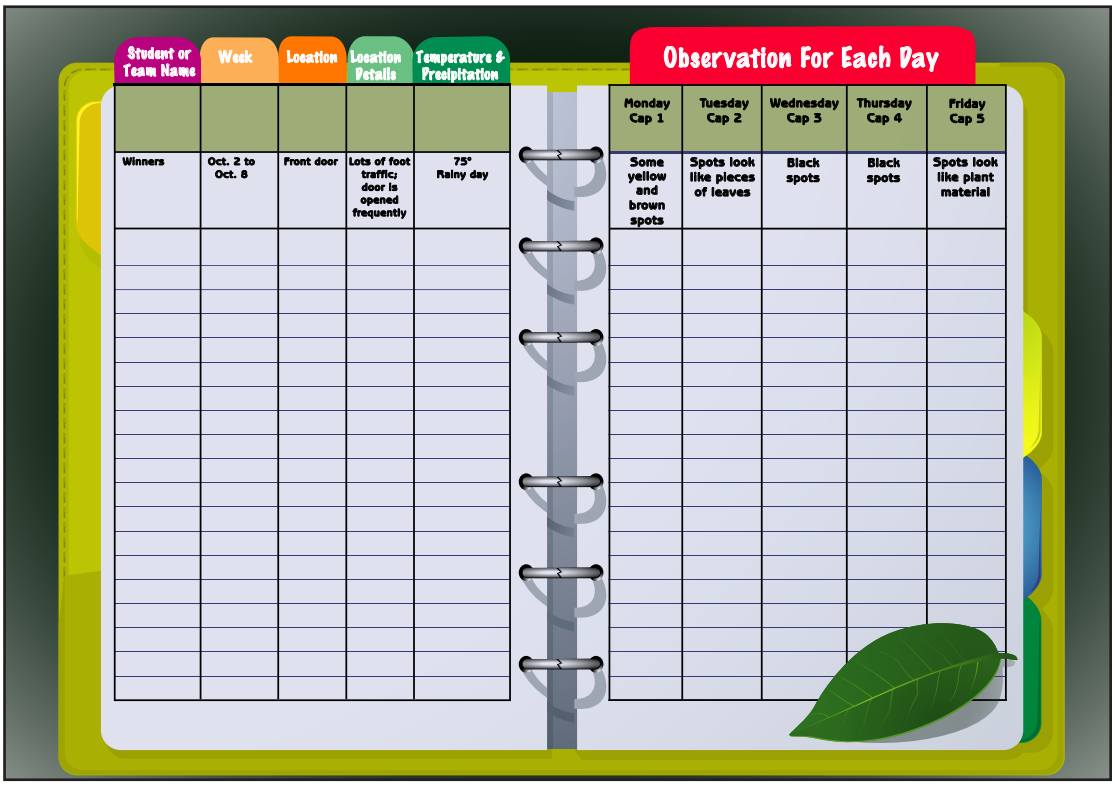
3. Sampling activities

a. If you decided to do sampling daily, then each day students will remove one bottle cap and cover the hole of the previous day. Remind them to be careful not to disturb the previous day's samples.

b. Ask the students to record their daily observations in a spreadsheet or in their journals. Have the students write down the weather conditions for that day. You can use a cardboard or a paperboard sheet to develop an observation chart or use a computer. Let the students record the information. An example of a chart to record observations is below.

c. If possible, take pictures of the samples collected each day so that if something happens to the sampler, the students still have some data to review.

Example of Observation Chart



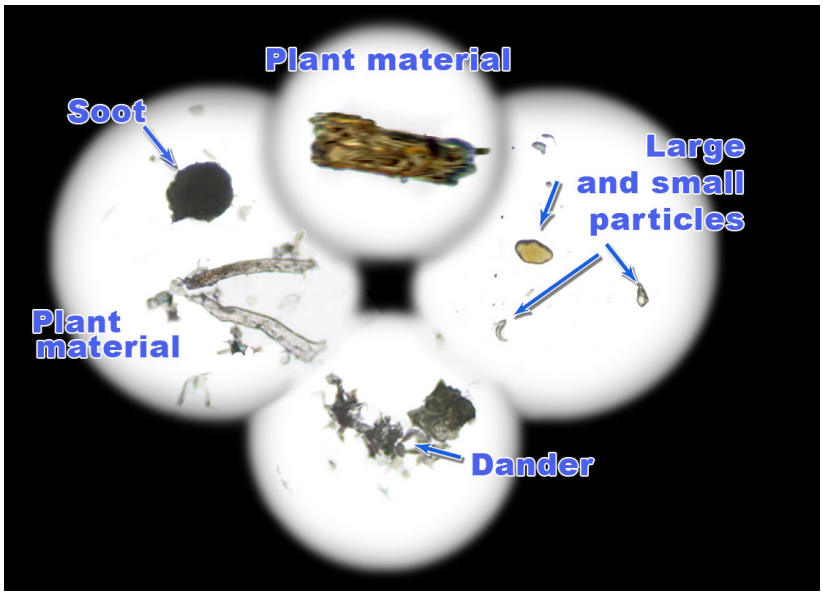
Student or Team Name	Week	Location	Location Details	Temperature & Precipitation	Observation For Each Day				
					Monday Cap 1	Tuesday Cap 2	Wednesday Cap 3	Thursday Cap 4	Friday Cap 5
Winners	Oct. 2 to Oct. 8	Front door	Lots of foot traffic; door is opened frequently	75° Rainy day	Some yellow and brown spots	Spots look like pieces of leaves	Black spots	Black spots	Spots look like plant material

4. Recording observations

a. Have the students carefully retrieve the air particle samplers.

b. Using magnifying glasses or microscopes have the students look at each of the samples collected. For each sample, the students will attempt to identify and count the different types of particles that were collected on the sticky areas. An example of what the students may see is given in the figure on page 17. They will also collect a lot of small fibers, lint, hair etc.

c. On a sheet of paper or in their journal, have the students draw the collected particles they see through the magnifying glass or microscope. Make sure they use proper proportions for the particles, for instance, if the particle takes up half the viewing screen, then it should be drawn as such.



Possible materials that could be observed with the magnified glass

d. As a class, create two size categories for the PM collected. Count the number of PM collected in each category. Calculate the fraction of PM in the large size category (coarse) and small size category (fine) in relation to the total number of particles collected.

Example: total particle observed: 10

Coarse: 3 of 10; 3/10 *Fine: 7 of 10; 7/10*

5. Discussion of results

Discuss the results observed from each location and encourage the students to develop conclusions using the following example questions.

a. What do you notice when you compare your results with the particles in the picture above (dust, ash, soot, and/or other particles)? Remember depending on the time of year, pollen may also be present.

b. What types, sizes, and numbers of particles were found at each location? Which location showed more particles? Which size category was the most relevant? Coarse or fine?

c. Did the selected locations give interesting or important results? Should other school areas have been part of the experiment?

d. How did weather conditions influence the results? Ask the students how different seasons might affect results?

e. How did human activities at the school affect the results like cars/buses, open entering/exiting doors?

f. Do you think the materials used to construct the sampler affected the results? Could you improve the design to be more effective? If yes, then how can you make the design more effective?

GLOSSARY

- Particulate Matter (PM)- defined by air pollution scientists as a mixture of both extremely small particles and liquid droplets in the air. It has many components such as dirt, mold, pollen, soot, smoke, metals, droplets of acids and organic chemicals. Complex chemical reactions occur in the air as chemicals, water vapor and PM mix. Some PM occurs naturally from dry soil, vegetation, fires and volcanoes while some occurs due to human activity such as burning fuel for energy, industrial processing, and farming.
- Air pollution- mixture of solid particles and gases, man-made and natural, suspended in air. Air pollution can cause human health problems and environmental damage.
- Respiratory system – the system of organs and structures, such as lungs in mammals and gills in fish, involved in the exchange of oxygen and carbon dioxide between an organism and its environment.
- Cilia- fine hair like projections from certain cells in the respiratory tract that sweep in unison to filter fluids and particles from the air being inhaled.
- Alveoli - tiny sacs within our lungs that allow oxygen and carbon dioxide to move between the lungs and bloodstream.
- Air Quality Index - simplified system for reporting daily air quality measurements. It uses five categories to indicate how clean or polluted your air is, and whether you may experience health impacts due to the level of air pollution. The AQI focuses on health affects you may experience within a few hours or days after breathing polluted air.
- Air sampling- the collection of airborne contaminants using a mechanical device such as a pump to draw the air/contaminant mixture into or through the sampling device such as a sorbent tube, filter, or sample bag.

NC STANDARDS

Grade 3:

Science

3.P.2.1 Recognize that air is a substance that surrounds us, takes up space and has mass.

Grade 4:

Science

4.PCH.2.1 Identify the basic components and functions of the respiratory system.

Grade 5:

Science

5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.

5.E.1.1 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

RESOURCES

1. Activity of how to analyze EPA air data. University of Northern Iowa. http://www.uni.edu/storm/downloads/highschool/Particulates.pdf
2. Air Pollution. World Health Organization. http://www.who.int/topics/air_pollution/en/
3. Air Pollution in the World: Real time Air Quality map. Air Quality Index. http://aqicn.org/map/world/
4. Air Now. Environmental Protection Agency. http://airnow.gov/index.cfm?action=aqibasicsaqi
5. Effects of Common Air Pollutants, Environmental Protection Agency. http://epa.gov
6. EPA air data site. https://www.epa.gov/environmental-topics/air-topics
7. It's Our Air. Division of Air Quality. Department of Environmental Quality. https://vimeo.com/129567885
8. Lung attack. Pima County, Department of Environmental Quality. http://web1.pima.gov/deq/lungattack/lungplay.htm
9. Monitor your air quality using an Arduino-Android DIY sensor. Kirsten Dirksen. YouTube. https://www.youtube.com/watch?v=aYGzRV-W3ec Nephelometer video1. RGKleid. YouTube.https://www.youtube.com/watch?v=beEh4kE66vM
10. Particulate Matter Matters! University of Northern Iowa. http://www.uni.edu/storm/downloads/highschool/Particulates.pdf
11. PM graphic. Environmental Protection Agency. http://www.epa.gov/pm/graphics/pm2_5_graphic_lg.jpg
12. Pollution Patrol. Try Engineering. http://tryengineering.org/lessons/pollutionpatrol.pdf

FOOTNOTES

[1] What is PM? http://www.epa.gov/region1/airquality/pm-what-is.html

[2] http://www.epa.gov/pm/graphics/pm2_5_graphic_lg.jpg

[3] http://airnow.gov/index.cfm?action=aqibasics.aqi

[4] http://www.who.int/topics/air_pollution/en/

[5] http://aqicn.org/map/world/

[6] Effects of Common Air Pollutants, EPA. http://epa.gov

[7] Lung Attack. http://web1.pima.gov/deq/lungattack/lungplay.htm

[8] https://vimeo.com/129567885

[9] https://www.youtube.com/watch?v=aYGzRV-W3ec

[10] https://www.youtube.com/watch?v=beEh4kE66vM

ACKNOWLEDGEMENTS

NC Air Awareness Curriculum Developers
Keith Bamberger
Teresa D. Colón
Jonathan Navarro

NC Air Awareness Editors
Robin Barrows
Aditi Chakravarty
Sharon Martin

STEM Evaluator
Paula Hemmer

Videos, Photos and Informative Materials
DEQ, Pima County, AZ
Roberta M. Burns, Kentucky Division for Air Quality
Duke Garden Summer Camp

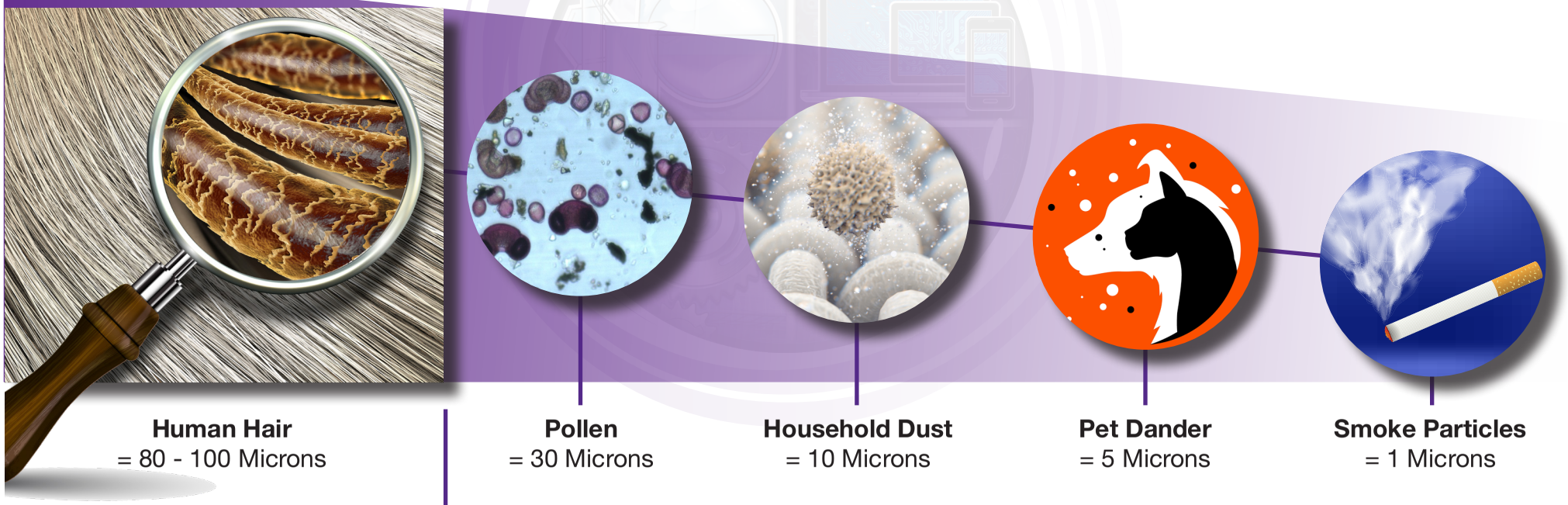
Spanish Translations & Outreach
Teresa D. Colón

Graphic Design
Jerome Moore

Reference Scale of Particles Size

Grades 3-5

PARTICLES MAGNIFIED FOR COMPARISON



Human Hair
= 80 - 100 Microns

Pollen
= 30 Microns

Household Dust
= 10 Microns

Pet Dander
= 5 Microns

Smoke Particles
= 1 Microns

40 Microns — Invisible to the human eye — 0.3 Microns