Air Quality & Health

HASPI Medical Anatomy & Physiology 14c

Lab Activity

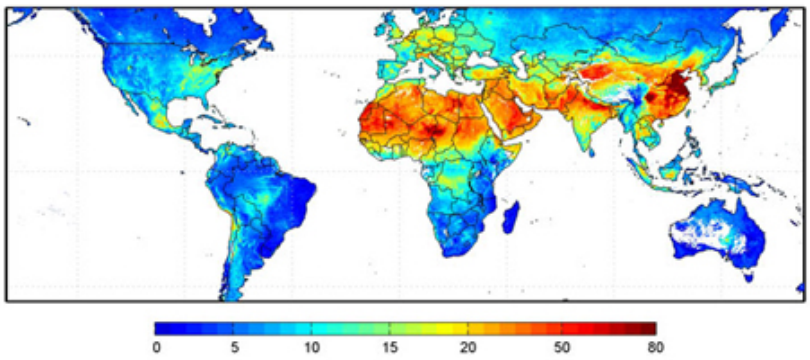
Name(s): _____

Period: _____ Date: _____

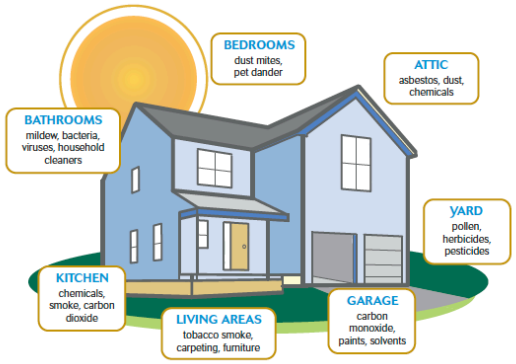
Background

Air Pollution & Health

Air pollution can have profound impacts on our respiratory health in both developed and developing countries. Outdoor air pollution is estimated to cause 1.3 million deaths and indoor air pollution 2 million premature deaths, annually. More than half of those deaths are contributed to respiratory distress and infection that can lead to pneumonia in children under 5 years of age. It is estimated by the World Health Organization (WHO) that more than half of the world population is at risk of respiratory illness caused by air pollution. This is of particular concern in developing countries where the particulate matter (PM) concentrations are estimated to be 10-50 times higher than the WHO levels for "minimum risk". The primary source of indoor particulate matter pollution is the burning of coal and wood for heating and cooking.



http://media.treehugger.com/assets/images/2011/10/global-air-pollution-map.jpg



http://www.nocoenergysolutions.com/wp-content/uploads/2012/04/IAQ-Graphic_AirAdvice.png

In California, asthma occurrence linked to air pollution is higher than anywhere else in the United States. Since 1980, the prevalence of asthma has increased by 76% in the United States, and more than 9.9% of the entire U.S. population has been diagnosed with asthma. In California, 12.3% of the population has been diagnosed with asthma. WHO has developed guidelines for air quality and health risk in order to reduce air pollution and improve respiratory health worldwide.

The following tables summarize some of the major pollutants that pose a risk to respiratory health. The minimum risk level is the level present in the air before there is a possibility that a normal and healthy adult may start to experience acute or chronic respiratory distress.

Particulate Matter (PM)

Minimum Risk Level	$PM_{2.5}$ 0.4 ppm or PM_{10} 0.8 ppm *(PM is separated by size, with a PM_{10} particle having a diameter of less than 10 µm and a $PM_{2.5}$ particle having a diameter less than 2.5 µm.)*
Sources	Most simply, particulate matter is particles of matter suspended in the air. The most common source of PM pollution is smoking. Other sources include sulfate, ammonia, sodium chloride, carbon, mineral dust, nitrates, and water.
Health Impact	When inhaled, particulate matter can enter the lungs and interfere with efficient gas exchange. Acute exposure can cause respiratory infections. Chronic exposure can lead to COPD, respiratory distress, cardiovascular disease, and even has been linked to lung cancer. In cities with higher than normal PM concentrations, the mortality rate is 15-20% higher than those with low PM concentrations.

Ozone (O_3)

Minimum Risk Level	0.08 ppm
Sources	Ozone is normally found in the upper layers of the atmosphere and has no impact on human health at that level. Unfortunately, ozone is also created through a chemical reaction between sunlight and pollutants in the atmosphere emitted by industrial processes and vehicles. This reaction causes the ozone to remain at ground level, and is one of the major pollutants found in smog.
Health Impact	Excess ozone at the ground level has been known to cause respiratory distress, cardiovascular disease, an increase in the occurrence of asthma attacks, and reduced overall lung function. The average peak concentration in American cities is 0.15 – 0.50 ppm.

Nitrogen Dioxide (NO_2)

Minimum Risk Level	0.053 ppm
Sources	Nitrogen dioxide is produced through combustion most often produced by engines, power generators, and heating processes. It is also produced by testing nuclear weapons and creates the reddish color in “mushroom clouds.”
Health Impact	Chronic exposure to NO_2 can cause bronchitis and reduce overall lung function. In high levels, NO_2 can cause lung edema and lead to poisoning.

Sulfur Dioxide (SO_2)

Minimum Risk Level	5 ppm
Sources	Sulfur dioxide is produced by burning fossil fuels (gasoline) and ores that contain sulfur. This is most commonly done to create energy for vehicles, heating, and power. SO_2 can become particularly dangerous as it combines with water to create sulfuric acid. SO_2 in the atmosphere is the primary cause of acid rain. Due to this the U.S. has drastically reduced its SO_2 production. China is the largest producer at 25.5 million tons in 2009, which is a 27% increase from 2000!
Health Impact	SO_2 can increase the occurrence of asthma attacks, acute bronchitis, acute respiratory distress, and respiratory infection. SO_2 can also cause irritation to the nasal cavity and eyes.

Carbon Monoxide (CO)

Minimum Risk Level	70 ppm
Sources	Carbon monoxide is produced by the burning of fossil fuels, and is of particular concern as an indoor pollutant when it is produced in large amounts by residential stoves and heaters.
Health Impact	CO can cause headaches, nausea, lack of mental acuity, and chest pain. Very high levels of CO can lead to death by suffocation as the CO is capable of binding to hemoglobin, therefore preventing oxygen from binding.

WHO. 2000. *Air quality guidelines for Europe, 2nd ed. Copenhagen, World Health Organization Regional Office for Europe, (WHO Regional Publications, European Series, No. 91).*

Materials

Petri plates (2)
Q-tip
Paper towels
Petroleum jelly
Dissecting microscope or magnifier

Procedure

The goal of this activity is to obtain a measurement of particulate matter pollution that may be present in the indoor OR outdoor environments that you commonly visit. You will want to choose a location that you may suspect of having some air pollution, but it is not necessary. You will be measuring the amount of PM that builds up over a week period. Consider weather and whether other students may be able to disturb your test before deciding on a location.

Directions

		✔when complete
Step 1	Obtain 2 Petri dishes. One plate will be the control and the other will be placed in an outdoor or indoor location of your choice. Choose a location that will not easily be disturbed (on top of a cabinet, hidden under a bush, etc.)	
Step 2	Using a marker, write your initials on the side of both plates. Label one plate "Control" and the other plate with the location you decide to place your plates.	
Step 3	Using a ruler, draw a 4 cm x 4 cm grid on the bottom of each plate. Each box within the grid must be 1 cm x 1 cm, and there will be 16 boxes total.	
Step 4	Collect a small amount of petroleum jelly on the end of the Q-tip.	
Step 5	Remove the lid from the plates, and coat the bottom of each plate with a thin layer of petroleum jelly. Immediately return the lid to each plate.	
Step 6	Take both plates to the location you chose. Remember that the plates should be somewhere they will not be disturbed. If needed, place an explanatory note with the plates.	
Step 7	The lid on the control plate will remain on throughout the experiment. Remove the lid on the test plate and place it under the bottom. The petroleum jelly of the test plate should be exposed to the air.	
Step 8	The plates will remain in this location for a week.	
During the Experiment		
Step 9	Check on the plates periodically to make sure they have not been disturbed.	
Step 10	Keep track of daily weather, temperature highs/lows, and wind conditions in Table 1. Go to www.weather.com and enter the zip code for this information.	
Step 11	Record the air quality index (AQI) daily in Table 1. Go to www.airnow.gov and enter the zip code to get the daily AQI for the area where the plates are located.	
After 1 Week		
Step 12	Collect both of your plates from the location they were placed. Return the lid to the test plate when you collect it.	
Step 13	Using a dissecting microscope or magnifier, count the number of visible particulate matter in EACH BOX for the control and test plates. Count even the smallest visible dust particle.	
Step 14	Record the number of particles for each box in Figure A and Figure B below.	
Step 15	Determine the total particles in the overall 4 cm x 4 cm box for the control plate and test plate. Record below each figure.	
Step 16	Write your location and the "Total Particulate Matter" number for Figure B on the board to share with the class.	
Step 17	Record the class results in Table 2.	

Table 1. Weather, Temperature, and AQI					
	Weather Conditions	Temperature High	Temperature Low	Wind Conditions	Air Quality Index (AQI)
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					

Figure A. Control Plate

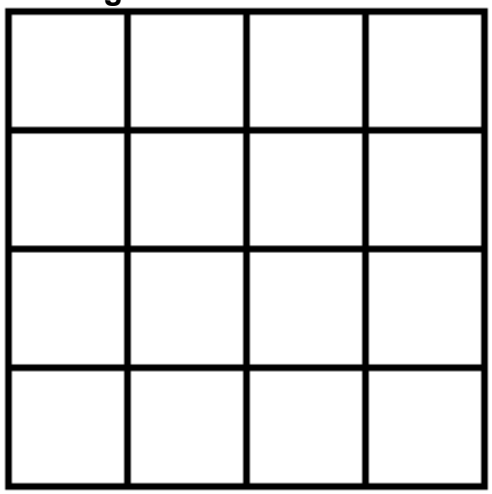
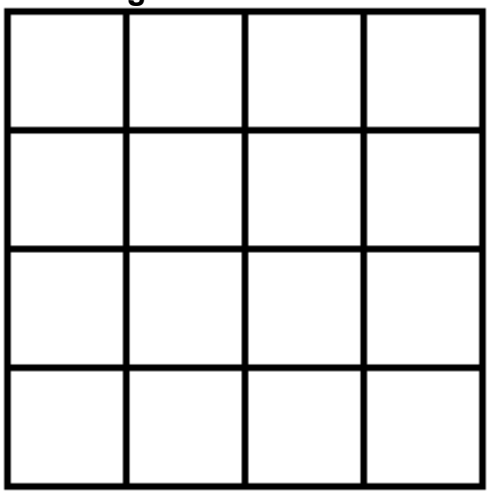


Figure B. Test Plate



Total Particulate Matter: _____

Total Particulate Matter: _____

Table 2. Class Results			
Location	Total Particulate Matter	Location	Total Particulate Matter

Analysis Questions - *on a separate sheet of paper complete the following*

1. What was the AQI range for the duration of your experiment?
2. Were there any weather conditions that could have impacted your results?
3. How did the Total Particulate Matter amount compare from/to the Control and Test plates?
4. Were you able to identify the source of any of the particulate matter? What was the source?
5. Hypothesize as to whether higher or lower temperatures would cause higher air pollution.
6. Using the class data, which location had the most PM? Hypothesize as to why this location had the most pollution.
7. Looking at the class data, was there more PM pollution found in indoor or outdoor locations?
8. **CONCLUSION**: In 1-2 paragraphs summarize the procedure and results of this lab.

Review Questions - *on a separate sheet of paper complete the following*

1. How many deaths are caused by outdoor air pollution annually?
2. How many deaths are caused by indoor air pollution annually?
3. What age group is most at risk for respiratory distress caused by air pollution?
4. What is the role of WHO in regards to air quality?
5. How does the PM concentration in developing countries compare to WHO's minimum risk level for air pollutants?
6. How does the WHO define "minimum risk level?"
7. What is the primary source of indoor PM pollution?
8. Which state in the U.S. has the highest prevalence of asthma related to air pollution?
9. List two sources of particulate matter pollution, and at least two health impacts.
10. Where is ozone normally found?
11. List two sources of ozone pollution, and at least two health impacts.
12. List two sources of nitrogen dioxide pollution, and at least two health impacts.
13. List two sources of sulfur dioxide pollution, and at least two health impacts.
14. List two sources of carbon monoxide pollution, and at least two health impacts.