Deliver Change

Key Stage 3 (Year 7 & 8)
BIOLOGY

Lesson 5: "Health effects of air pollution"

Length of Lesson: 45 minutes

National Curriculum in England, for teaching from September 2015
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf *Biology page 60 & 61*

CURRICULUM

Biology:
Gas exchange systems
- The mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume.
- The impact of exercise, asthma and smoking on the human gas exchange system.

CURRICULUM

Biology:
Interactions and interdependencies.
- How organisms affect, and are affected by, their environment, including the accumulation of toxic materials.

LESSON PLAN

Part 1: Begin the class by handing out the two diagrams of the respiratory system and alveoli exchange, as well as the 'Health effects of air pollution' text, provided.

This lesson will best be taught as a follow up class to 'Lesson 4' on diffusion and air pollution. If not all students have been taught Lesson 4, i may be useful for the teacher to tell the class briefly about how air moves in and out of the lungs and alveoli. Explain to the class that pollutants that are found in much of the air around cities, such as carbon monoxide and nitrogen oxides, are a similar size to oxygen and carbon dioxide. This means that we can inhale them and they will follow a similar route that oxygen will take when it enters our lungs. If the air is polluted, pollutants can be transported in the blood and sent to our cells, which should usually only receive oxygen. This harms our cell system and can cause us to become ill.

Next, write on the board: "Do you think that air pollution levels could be high enough to affect people's health? Do you think these levels can be reached in our local environment?"

Ask the students to state why or why not.

Next, ask the class to indicate how air flows into our system and where it goes once being transported by the blood (here the pictures will be useful).

Part 2: Students will be asked to read through the document 'Health impacts of air pollution'. After reading the text students will be asked to answer a set of questions provided. This activity can be completed in pairs.

Part 3: The teacher will ask the class to conduct a research activity, which can take place either during the class, or at home, as long as the students can research the web. Students are asked to find out *which* other areas of the body might be affected when exposed to air pollutants. The students must then write brief notes about *how* these areas are affected.

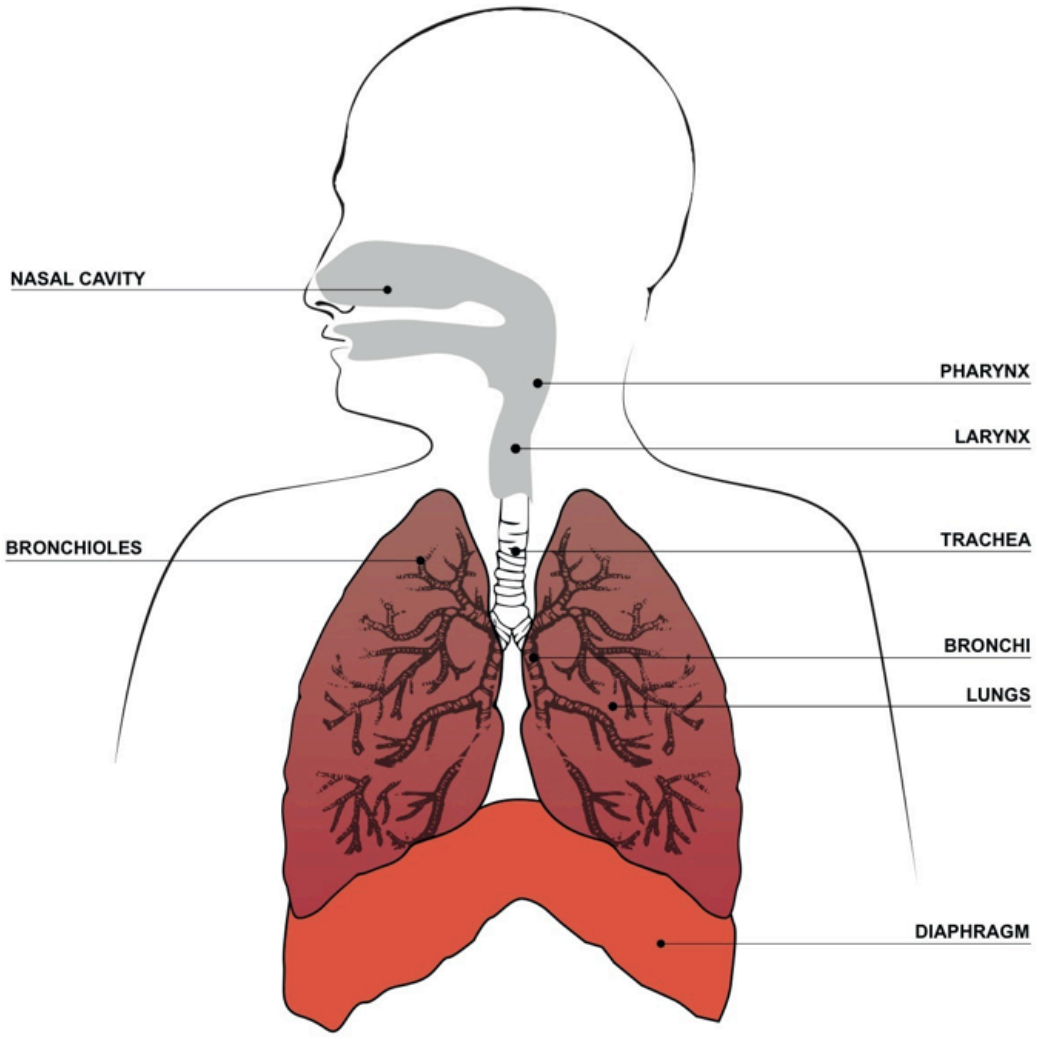
LEARNING OBJECTIVES

- Students will understand that poor air quality can have an impact on other areas of the body besides the lungs.
- Students will gain an understanding of the pollution levels in and around their local environment.

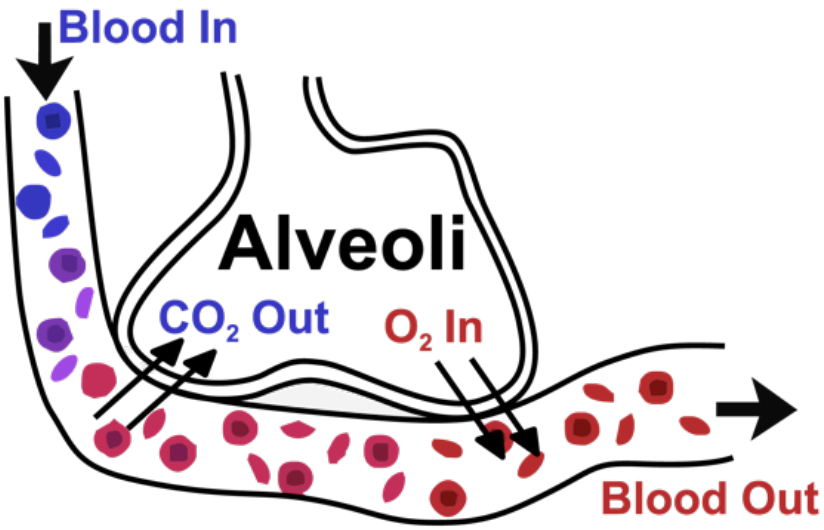
LESSON REQUIREMENTS:

- Health Impacts handout
- Question sheet handout
- Gas exchange diagrams handout
- Pencils and Erasers
- Web access if applicable

Part 1



Diagrams of the Human respiratory and circulatory systems: Gas exchange.



Part 2:
Health effects of air pollution
Please read the text below

Air Pollution and its impact on everyone

Air pollution is something we can't escape. We breathe it every day. In fact, every minute of everyday, we breathe six to ten litres of air. If the air around us carries pollutants, those pollutants enter our bodies and can affect us in many ways.

The air pollution is such a health risk that it is said to have caused almost 9,500 premature deaths in London in 2010, and this is is from only two key pollutants: particulate matter 2.5 and nitrogen dioxide. Enough people are affected, and affected badly enough, that just in London, the health impacts of air pollution costs us millions of pounds every year.

Air pollution is especially harmful to the very young and old. Infants and young children are at risk because their lungs are not fully developed and because they breathe faster. The elderly are at risk because their bodies are no longer as effective at dealing with environmental stress. Of course, since the respiratory system comes in direct contact with the air we breathe, it is the body system most likely to be affected by air pollutants. So people who already have asthma, emphysema, or other respiratory conditions, people with heart or circulatory problems, and cigarette smokers are especially susceptible to the effects of air pollution.

People who are young and healthy can be affected by pollution too. Air pollution can affect anyone. Even healthy teenagers, young adults, and strong athletes can suffer negative effects from high pollution levels, especially when exercising outdoors.

A Tricky Question

It's a real challenge for scientists to study the health effects of different air pollutants. It wouldn't be ethical for researchers to just put people in a lab and expose them to high levels of a pollutant. Outside the lab, people who live in heavily polluted areas are exposed to not just one pollutant but to many pollutants. Also, the concentration of each pollutant is changing all the time, in some cases independently of other pollutants. All of this makes it difficult to separate out the effects of each pollutant.

In addition, how susceptible people are to the effects of air pollutants can vary widely. Think about a roomful of healthy people who are all exposed to the same cold virus. Some will develop a bad cold, others a mild cold, and others no cold at all. In a similar way, susceptibility to pollutants can vary greatly even among a group of healthy individuals.

Finally, there are always many influences on our health. If you develop symptoms that might be caused by air pollution, it's often difficult to be sure that pollution was "the"

cause. Just as with other health problems, there are likely to be several factors affecting your health.

How Much Do We Know?

One way to study the relationship between air pollution and health is to compare hospital records and death records to pollutant levels. Researchers have found that during extreme air pollution events, hospital admittances for respiratory problems increase. Death rates also increase, especially among the elderly and those who already have respiratory problems.

Another type of research involves evaluating the effects of long-term exposure to pollutant levels that are high but not extreme. In one study, scientists analysed medical records of several thousand people who lived in an area where pollutant levels went above the National Ambient Air Quality Standards for 42 days or more. These people were 33 percent more likely to have bronchitis, 74 percent more likely to have asthma, and 37 percent more likely to have lung cancer than people who lived in an area with clean air. Other studies have found these kinds of results as well.

Finally, being affected by air pollutants is not just an "either/or" question. People can suffer from pollution to varying degrees. Although they may not be diagnosed with a specific disease, their health may be affected on a long-term basis in a way that reduces their quality of life.

In general, we know that long-term exposure to irritants in the air can cause swelling and constriction of the airways, increased production of mucous, and paralysis of bacterial destroying cells. Normally, the cilia of the epithelial cells that line the airways make sweeping movements to keep the airways clean. The cilia move mucous, along with germs and dirt caught in the mucous, out of the respiratory tract. Air pollutants can irritate the cilia, so that their protective action slows down or even stops. This leaves sensitive tissues unprotected.

The microorganisms and bits of foreign matter in the air are more likely to remain in the lungs. Here they can cause infections, lead to the development of lung diseases like chronic bronchitis and emphysema, and increase the chances of lung cancer.

Although the part of our bodies most affected by air pollutants is the respiratory system, the circulatory system works in close relationship with the respiratory system, so it can be affected too. If the respiratory system is damaged or diseased, then it will not be as effective at exchanging gases with the blood. With less oxygen in the blood, the heart must work harder, pumping more blood to deliver the same amount of oxygen to the body. In this way, the heart and arteries can be stressed.

When we inhale particulate matter (PM_{10} and $PM_{2.5}$), these tiny bits of foreign matter travel deep into the lungs where they become lodged in the alveoli. These small, balloon-like sacs are the point in our bodies at which oxygen exchange occurs. This is where the

lung removes carbon dioxide from the blood and replaces it with oxygen from the air. Very tiny particulates, those less than one micron, can stay trapped here for years.

They can irritate the alveoli, reducing their ability to work properly, and cause long-term chemical and structural damage to the lungs.

In contrast, carbon monoxide is unusual in that it has no direct effect on the lungs but is absorbed by the blood. Carbon monoxide readily combines with haemoglobin in red blood cells, taking the place of some of the oxygen that should be entering the bloodstream. Every moment, we are interacting with the air around us. Our bodies are constantly exchanging molecules with the atmosphere. Just as breath is essential to life, so too is the quality of the air we breathe essential to good health and the quality of our lives.

Source: *Students For Clean Air.* Clean Air Program. Pima County Department of Environmental Quality. Tucson, Arizona

Question sheet 'Health effects of air pollution'

1. Please write down how much air we breathe every minute :
2. In 2010, how many premature deaths did air pollution cause in London?
3. Which body system is most likely to be affected by air pollutants?
4. Who is affected by air pollution?
5. Why is it difficult to determine the health effects of different air pollutants?
6. Briefly explain how researchers study the health impacts of air pollution:
7. Which system, besides the respiratory system, can be affected by air pollution?
8. Describe the health effects of particulate matter:
9. Describe the health effects of carbon monoxide:

Questions and Answers to 'Health effects of air pollution'

1. Explain how much air we breathe every minute:

Every minute of everyday, we breathe six to ten litres of air.

2. Last year, how many premature deaths did air pollution cause in London?

The air pollution is such a health risk that it is said to have caused over 4000 premature deaths last year just in London.

3. Which body system is most likely to be affected by air pollutants?

Since the respiratory system comes in direct contact with the air we breathe, it is the body system most likely to be affected by air pollutants.

4. Who is affected by air pollution?

People who are young and healthy can be affected by pollution too. Air pollution can affect anyone. Even healthy teenagers, young adults, and strong athletes can suffer negative effects from high pollution levels, especially when exercising outdoors.

5. Why is it difficult to determine the health effects of different air pollutants?

It wouldn't be ethical for researchers to just put people in a lab and expose them to high levels of a pollutant. People who live in heavily polluted areas are exposed to not just one pollutant but to many pollutants. Also, the concentration of each pollutant is changing all the time, in some cases independently of other pollutants. All of this makes it difficult to separate out the effects of each pollutant. In addition, how susceptible people are to the effects of air pollutants can vary widely.

6. Briefly explain how researchers study the health impacts of air pollution:

One way to study the relationship between air pollution and health is to compare hospital records and death records to pollutant levels. Researchers have found that during extreme air pollution events, hospital admittance for respiratory problems increase. Death rates also increase, especially among the elderly and those who already have respiratory problems. In one study, scientists analyzed medical records of several thousand people who lived in an area where pollutant levels went above the National

Ambient Air Quality Standards for 42 days or more. These people were 33 percent more likely to have bronchitis, 74 percent more likely to have asthma, and 37 percent more likely to have lung cancer than people who lived in an area with clean air.

7. Which system, besides the respiratory system, can be affected by air pollution?

Circulatory system

8. Describe the health effects of particulate matter:

When we inhale particulate matter ((PM$_{10}$ and PM$_{2.5}$), these tiny bits of foreign matter travel deep into the lungs where they become lodged in the alveoli. These small, balloon-like sacs are the point in our bodies at which oxygen exchange occurs. This is where the lung removes carbon dioxide from the blood and replaces it with oxygen from the air. Very tiny particulates, those less than one micron, can stay trapped here for years. They can irritate the alveoli, reducing their ability to work properly, and cause long-term chemical and structural damage to the lungs.

9. Describe the health effects of carbon monoxide:

Carbon monoxide is unusual in that it has no direct effect on the lungs but is absorbed by the blood. Carbon monoxide readily combines with haemoglobin in red blood cells, taking the place of some of the oxygen that should be entering the bloodstream.

Part 3

Once the students have completed the reading task and answered the questions, ask the class to conduct a research investigation using the web and find out which other areas of the body air pollution can affect. The students must then write brief notes about *how* these areas are affected.

This can also be a homework activity.