

LESSON PLAN: AIR POLLUTION AND ITS CONSEQUENCES ON HUMAN HEALTH

<p>Objective</p>	<p>Main Goal To demonstrate the importance of air for human health by defining its characteristics and main dangerous pollutants.</p> <p>Subsidiary Goals</p> <ul style="list-style-type: none"> • To define what air is and its characteristics. • To describe the main air pollutants and their effects on human health. • To develop an activity where the student puts into practice the knowledge acquired.
<p>Prior knowledge required</p>	<p>In this teaching module, no previous knowledge of the subject is needed since it is intended to create awareness in the student about the importance of caring for the air and the impacts its contamination can generate.</p>
<p>Indicators of performance</p>	<ul style="list-style-type: none"> • Knowledge: The student understands the importance of caring for the air and the impacts that its pollution can generate. • Doing: The student questions themselves about the topics taught and questions their classmates, teachers, family, and community members to learn more. • Being: The student identifies what air is, its characteristics, pollutants, and its possible effects on human health. • Learning to learn: Students discuss the lesson in small groups and carry out the proposed activities.
<p>Anticipated Problems and Solutions</p>	<ul style="list-style-type: none"> • Students express disinterest: To guarantee student participation, the material will be prepared in a way that its teaching is interactive and encourages participation. The module should not be very long. Otherwise, divide the class into two sessions. Indicate from the beginning what activities will be developed to attract the students' attention and increase their interest. • Reluctance to participate: This can be addressed by dividing students into smaller groups for discussions and asking students what they would like to learn. • Lack of attention: The time of the master session could be reduced, and the issues addressed while the activity is being carried out.
<p>Materials</p>	<ul style="list-style-type: none"> • Detailed Thematic Content for Teachers (Background)

	<ul style="list-style-type: none"> • Topic Content Slides • Activity Instructions • Materials to carry out the activities (it is assumed that each class will have between 40 and 44 students) <ul style="list-style-type: none"> ○ Plastic bottle (x1) ○ Paper ○ Plastic cups (x40x2) ○ Straws (x50) ○ Water
<p>Background</p>	<p>Introduction</p> <p>Air is a fundamental element for life; therefore, its contamination represents a risk to the environment and the health of living beings, causing various respiratory and cardiovascular diseases in humans in the short and long term (World Health Organization Health, 2022a). The World Health Organization (2022a) indicates that air pollution can cause up to 4.2 million premature deaths annually, of which 91% occur in low- and middle-income countries. Likewise, in these countries, a large part of the population still uses biomass (such as wood and agricultural residues) and coal as a fuel for cooking and heating their homes, which puts some 2,600 million inhabitants at serious risk. This contamination of indoor spaces can cause diseases such as ischemic heart disease, chronic obstructive pulmonary disease, lung cancer, and the premature death of almost 4 million people annually (World Health Organization, 2022b). Consequently, this module seeks to create awareness in children between 6-8 high school grades about air, its properties, and its importance. Likewise, some contaminants and the possible consequences on human health are described. Some diseases are highlighted to emphasize the importance of living in an environment with clean air through games and dynamics.</p> <p>The Air and its Characteristics</p> <p>Air is a more or less homogeneous mixture of gases that surrounds the Earth, forming layers that constitute the atmosphere, which is contained by the force of gravity (Equipo editorial Etecé, 2023; Nuestraesfera.cl., 2014). Its physical properties correspond to those of the gaseous state of matter: it is transparent in most cases; has no defined volume; has low density; exerts pressure on objects</p>

(atmospheric pressure), and is sensitive to temperature (at higher temperatures, it expands and rises, and vice versa) (Equipo editorial Etecé, 2023). Its constitution varies according to the greater or lesser presence of contaminants. Approximately air has the following volumetric composition:

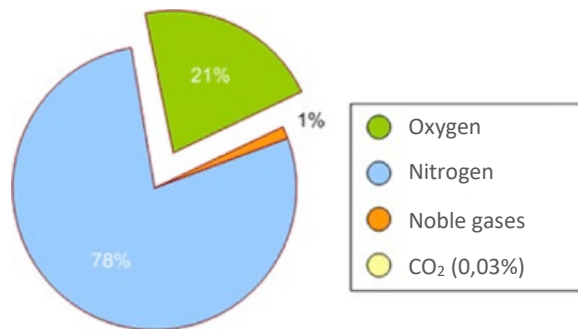


Figure 1. Volumetric composition of the air (Nuestraesfera.cl., 2014).

Among the noble gases present in the air are neon, krypton, xenon, or argon and may contain fewer toxic gases such as methane, carbon monoxide, and ammonia, which contaminate it as a result of anthropic activities (Equipo editorial Etecé. 2023). The following cyclical processes maintain the balance between these gases (Nuestraesfera.cl., 2014).

- Nitrogen (the main component of proteins present in all living beings) is regenerated through its incorporation into food chains and its subsequent return to the atmosphere (excrements).
- Oxygen (essential for the respiration of living beings) is recycled through photosynthesis in forests and marine phytoplankton.
- Carbon dioxide is regenerated from respiration, volcanism, or the combustion of materials such as wood.

Although these gases can be regenerated, the composition and quality of the air can be altered due to anthropic activities such as the indiscriminate felling of trees and the pollution of the seas, reducing the availability of atmospheric oxygen (Nuestraesfera.cl., 2014). Likewise, industrial activity increases carbon dioxide availability, altering the carbon–nitrogen cycle.

Among the functions of the air are to contain and transfer the gases necessary for plant respiration and photosynthesis and the water

vapor required for the vital hydrological cycle. In addition, the atmosphere (air) retains the Earth's heat by acting as a thermal regulator. Without this, the days would reach more than 75°C and the nights would be more than 130°C below zero. On the other hand, the air is a renewable energy source used to generate wind energy through wind turbines (Equipo editorial Etecé, 2023; Nuestraesfera.cl., 2014).

ACTIVITY 1: AIR IS A SUBSTANCE (See Activities Document).

Air Pollutants

Air pollution is a mixture of dangerous substances of human (combustion vehicles) and natural (volcanic eruptions) origin that represents a health hazard. This may not be seen at times, but its pungent odor can be perceived and taken as an alert. Air pollution is the leading cause of acid rain (rain that is more acidic than it should be, affecting soils and water). Burning fossil fuels such as coal, oil, natural gas, and the gasoline used in power plants, homes, cars, and airplanes pollute the air. When something burns, chemicals and particles are released into the air, which, combined with moisture, form acid rain (US Environmental Protection Agency, 2008).

On the other hand, health risks include respiratory diseases, cardiovascular diseases; Mellitus diabetes; obesity; and reproductive, neurological, and immune system disorders (National Institute of Environmental Health Sciences, 2022). Exposure to air pollution is so harmful to health that the World Health Organization (WHO) classified it in 2013 as carcinogenic to humans. Among the different sources of air pollution are emissions from motor vehicle traffic, which contains most of the elements of anthropogenic air pollution. These are (National Institute of Environmental Health Sciences, 2022):

- Tropospheric ozone: It is an atmospheric gas called smog when it is at ground level. It is created by the chemical reaction of pollutants emitted by automobiles, power plants, industrial boilers, refineries, and other sources with sunlight.
- Harmful gases: Emitted by motor vehicles and by-products of industrial processes, include carbon dioxide, carbon monoxide, nitrogen oxides (NO_x), and sulfur oxides (SO_x).

- Particulate Matter (PM): Originated by industrial emissions, vehicles, cigarette smoke, and burning organic matter. PM comprises chemicals such as sulfates, nitrates, carbon, or mineral dust.
- Volatile Organic Compounds (VOCs): They are called volatile because they vaporize at room temperature and organic because they contain carbon. VOCs are released during gasoline and natural gas combustion and are emitted by paints, cleaning supplies, pesticides, and craft materials such as glue.
- Polycyclic aromatic hydrocarbons (PAHs): These organic compounds contain carbon and hydrogen. They are produced by combustion, industrial processes (such as manufacturing iron, steel, and rubber products), and power generation. PAHs are also found in particulate matter, and 15 of the 100 PAHs released in the environment are carcinogens.

Hazardous or toxic air pollutants, are pollutants known or suspected to cause cancer or other irreversible severe or disabling health effects (US Environmental Protection Agency, 2022a). The United States Environmental Protection Agency lists 188 hazardous air pollutants, of which the majority are VOCs. This list includes, for example, benzene (industrial chemical and component of gasoline), methylene chloride (solvent and paint stripper), asbestos, toluene, and metals such as cadmium, mercury, chromium, and lead compounds (US Environmental Protection Agency, 2022b). Based on their effects, toxins can be classified as follows (Airnow.gov, n.d.):

- Mutagens (cause mutations in genetic material, such as dioxin, ozone, lead salts, benzene, and vinyl chloride).
- Carcinogens (cancer-inducing chemicals such as asbestos, benzene, beryllium, and chromium).
- Developmental toxins (or teratogens, directly harm the fetus, such as lead, organic mercury, alcohol, and cigarettes. Some can also affect the body during the first years of life).
- Neurotoxins (affect the nervous system. Some examples are cyanide, lead, and some forms of mercury).
- Hepatotoxins (affect the liver and can cause jaundice, cell death, cirrhosis, and cancer. Carbon tetrachloride is an example).

- Pulmonary toxins (affect the lungs causing irritation and constriction of the airways, necrosis, edema, fibrosis, and cancer, such as asbestos, arsenic, and radiation).
- Reproductive dysfunction agents (decrease fertility and the chance that the embryo will survive or cause teratogenic effects. An example is radiation).
- Acutely toxic agents (cause an adverse effect after a single short-term exposure. Formaldehyde is an example and irritates the eyes, skin, and respiratory tract).
- Chronically toxic agents (require prolonged or repeated exposures to cause an adverse effect, such as asbestos).

Health Impacts due to Air Pollution

According to the National Institute of Environmental Health Sciences (2022), air pollution can affect human health by generating:

- **Respiratory diseases**
Emphysema, asthma, and chronic obstructive pulmonary disease (COPD) are respiratory diseases that can develop from air pollution, affecting lung development. Specifically, PM and nitrogen oxide are linked to chronic bronchitis.
- **Cardiovascular diseases**
Short-term daily exposure of postmenopausal women to nitrogen oxides is associated with an increased risk of hemorrhagic stroke. Likewise, traffic-related air pollution is linked to reduced levels of good cholesterol, increasing the risk of developing cardiovascular disease and hypertensive disorders in pregnant women that can lead to premature birth, low birth weight, illnesses, and death of mothers and babies. Also, fine PM can affect blood vessel function and accelerate calcification in arteries.
- **Cancer**
Breast cancer is related to various causes, such as air pollution from transportation and airborne toxic substances (such as methylene chloride used in aerosol products and paint removers). Also, exposure to benzene can cause leukemia and is associated with non-Hodgkin's lymphoma. Lung cancer is related to the use of coal for power generation.

	ACTIVITY 2: BREATHE, BREATHE (See Activities Document).
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References

- AirNow.gov, U.S. EPA. (n.d.). *Properties of Air. Air Quality Workshop for Teachers: A Toolkit for Facilitators*. Retrieved February 6, 2023, from https://www.airnow.gov/sites/default/files/2020-10/properties_of_air.pdf.
- Equipo editorial Etecé. (2023, January 23). *Aire*. Enciclopedia Humanidades. Retrieved February 6, 2023, from <https://humanidades.com/aire/>.
- National Institute of Environmental Health Sciences. (2022, March 28). *La contaminación del aire y su salud*. U.S. Department of Health and Human Services, National Institutes of Health. Retrieved February 6, 2023, from <https://www.niehs.nih.gov/health/topics/enfermedades/contaminacion/index.cfm>.
- Nuestraesfera.cl. (2014, March 24). *El aire, sus características y funciones*. Retrieved February 6, 2023, from <http://nuestraesfera.cl/zoom/el-aire-sus-caracteristicas-y-funciones/>.
- Organización Mundial de la Salud. (2022a, December 19). *Contaminación del aire ambiente (exterior)*. Retrieved February 6, 2023, from [https://www.who.int/es/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/es/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).
- Organización Mundial de la Salud. (2022b, July 27). *Contaminación del aire doméstico y salud*. Retrieved February 6, 2023, from <https://www.who.int/es/news-room/fact-sheets/detail/household-air-pollution-and-health>.
- U.S. Environmental Protection Agency. (2008, April). *Learning about acid rain. A teacher's guide for grades 6 through 8*. Retrieved February 6, 2023, from <https://www.epa.gov/sites/default/files/2017-03/documents/teachersguide.pdf>.
- U.S. Environmental Protection Agency. (2022a, December 19). *What are Hazardous Air Pollutants?* Retrieved February 6, 2023, from <https://www.epa.gov/haps/what-are-hazardous-air-pollutants>.
- U.S. Environmental Protection Agency. (2022b, December 19). *Initial List of Hazardous Air Pollutants with Modifications*. Retrieved February 6, 2023, from <https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications>.