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Term Project Proposal

For my term project, I will focus on how air pollution causes lung cancer. Specifically, I plan to focus on how human activities result in an increase in air pollution, which leads to lung cancer. It is important to understand how air pollution caused by humans may be produced by useful and sometimes necessary human activity. However these actions will come around and eventually harm humanity. There are two origins of air pollution used to classify pollutants. Air pollution is categorized as either indoor air pollutants or outdoor air pollutants.[1] The main difference between indoor and outdoor pollutants is the origins of the pollutants and how they are spread into the atmosphere. Indoor pollutants tend to originate from smaller-scale carcinogens that include smoke that comes from the burning and smoking of tobacco cigarettes, cooking fumes, and soot along with dangerous chemical compounds including benzene, radon, and formaldehyde. Outdoor air pollution is a much broader category of air pollution and there are four origins the pollutants may stem from. Outdoor air pollutants may appear in the form of either physical, gaseous, chemical, or biological carcinogenic matter.[2]

Although both indoor air pollution and outdoor air pollution is extremely hazardous, studies have proven that outdoor air pollution is more harmful to human respiratory health. Indoor and outdoor air pollution is hazardous because of its gaseous state, which allows it to be inhaled into the body, and the carcinogens that take the form of extremely small particulate matter. Specifically, the particulate matter with a diameter of 2.5 microns or less, which is also referred to as fine particles.[3] The reason these particles are so dangerous is that once the particulate matter becomes less than 10 microns in diameter, they can reach deep inside the human lungs and even penetrate the bloodstream[4]. Examples of gaseous carcinogens include volatile organic compounds (VOCs), ground-level ozone ($O_3$), sulfur dioxide ($SO_2$), and nitrogen

[1] 1. M.U. Ali et al., “Air Pollution: A Culprit of Lung Cancer,” Journal of Hazardous Materials, April 15, 2022, http://www.sciencedirect.com/science/article/abs/pii/S0304389422007269.
[2] 1. M.U. Ali et al., “Air Pollution: A Culprit of Lung Cancer,” Journal of Hazardous Materials, April 15, 2022, http://www.sciencedirect.com/science/article/abs/pii/S0304389422007269.
[3] 1. “Particulate Matter (PM) Basics,” EPA, accessed April 6, 2025, https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#:~:text=Of%20these%2C%20particles%20less%20than,national%20parks%20and%20wilderness%20areas.
[4] 1. “Particulate Matter (PM) Basics,” EPA, accessed April 6, 2025, https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#:~:text=Of%20these%2C%20particles%20less%20than,national%20parks%20and%20wilderness%20areas.

oxides (NOx).[5] All of the outdoor pollutants caused by the burning of fossil fuels include sulfur dioxide and nitrogen oxides, specifically nitric oxide (NO) and nitrogen dioxide ($NO_2$).[6] Volatile organic compounds include aldehydes, ketones, aromatics, and other similar classes.[7] As said before, carcinogens in the form of both particulate matter and gaseous pollutants can be found in the makeup of either indoor or outdoor air pollution. Outdoor air pollutants tend to result from human activities, originating from industrial-grade sources. The human activities included in the production of outdoor air pollution include the manufacturing of paint, the production of pharmaceuticals, and the synthesis of plastic materials.

On the other hand, indoor air pollution is mainly made up of carcinogens that originate from the chemicals that result from sources involving different human activities. A large portion of the indoor air pollution produced comes from combustion products that are found in homes.[8] Combustion products may originate from tobacco smoke, wooden or gas stoves, fireplaces, gas space heaters, or unvented kerosene. From these sources, carbon monoxide (CO), nitrogen dioxide, and particulate matter are released.[9] Another source of indoor air pollution that people should be cautious of is pesticides, including termiticides, insecticides, rodenticides, fungicides, and disinfectants, which are made up of volatile organic compounds.[10] Another important pollutant that must be addressed is radon, which is a radioactive gas that is invisible and odorless.[11] When these gaseous, small, particulate matter carcinogens from indoor or outdoor origins become in contact with human respiratory stem cells, that's when cancerous cells form, causing lung cancer.

Although air pollution is known for contributing to global warming, changes in climates and ecosystems, and the well-being of other organisms it also plays a significant role in the

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[5] 1. “Air Pollution and Lung Cancer: A Review by International Association for the Study of Lung Cancer Early Detection and Screening Committee - Journal of Thoracic Oncology,” www.jto.org, accessed April 7, 2025, https://www.jto.org/article/S1556-0864(23)00601-9/fulltext.

[6] 1. “Air Pollution and Lung Cancer: A Review by International Association for the Study of Lung Cancer Early Detection and Screening Committee - Journal of Thoracic Oncology,” www.jto.org, accessed April 7, 2025, https://www.jto.org/article/S1556-0864(23)00601-9/fulltext.

[7] 1. “Air Pollution and Lung Cancer: A Review by International Association for the Study of Lung Cancer Early Detection and Screening Committee - Journal of Thoracic Oncology,” www.jto.org, accessed April 7, 2025, https://www.jto.org/article/S1556-0864(23)00601-9/fulltext.

[8] 1. “Indoor Pollutants and Sources,” EPA, accessed April 6, 2025, https://www.epa.gov/indoor-air-quality-iaq/indoor-pollutants-and-sources.

[9] 1. “Sources of Combustion Products,” EPA, accessed April 6, 2025, https://www.epa.gov/indoor-air-quality-iaq/sources-combustion-products.

[10] 1. “Pesticides’ Impact on Indoor Air Quality,” EPA, accessed April 6, 2025, https://www.epa.gov/indoor-air-quality-iaq/pesticides-impact-indoor-air-quality.

[11] 1. “How Radon Gets into Your Home,” Centers for Disease Control and Prevention, accessed April 6, 2025,https://www.cdc.gov/radon/about/radon-home.html#:~:text=Radon%20is%20an%20odorless%20and,when%20its%20source%20is%20groundwater.

growing number of lung cancer rates worldwide. Statistics have shown that 43 percent of lung cancer deaths have been a result of the accumulation of all forms of pollution. Out of this 43 percent, 29 percent of these deaths have been caused exclusively by air pollution.[12] The recent increase in the amount of indoor and outdoor air pollution emitted into the atmosphere also causes the rate of cancer cases to rise drastically. From the increase of carcinogens, particularly the respirable particulate matter, statistics illustrate that there is a 30% to 50% increase in the rate of lung cancer cases.[13] As mentioned briefly, the reason carcinogens, in the form of small particulate matter, are very harmful and hazardous to the human body is because of their ability to travel farther through breathing pathways and the respiratory system. The carcinogens then make their way into respiratory system cells and, from there, cause and often irreversible and major harm and damage to the lungs. The carcinogens and mutations within the cell's DNA damage the genetic information stored in the cell, causing, in turn, the cell to grow out of control and form a cancerous malignant tumor.

Through my research, I have learned that lung cancer may be caused by numerous air-polluting carcinogens far beyond just the commonly known cigarette smoke. Air pollution has many sources that can be traced to different communities, and regions worldwide and human-made products and machinery. The largest takeaway I discovered through my research was that numerous different chemicals and types of particulate matter make up what we know as cancerous carcinogens. Before my research I had a minimal understanding and knowledge on the topic of air pollution; therefore, I was surprised that air pollution could be traced back to both indoor and outdoor origins. Before my research, I had a minimal understanding and knowledge of the topic of air pollution; therefore, I was surprised that air pollution could be traced back to indoor and outdoor origins. Additionally, prior to my research, I was misled and superficially believed that the smoke from the burning of fossil fuels, fires, burning plastic, cigarettes, exposure to asbestos, or a family history of lung cancer were the main causes of lung cancer. However, now I know that other sources of air pollution can come from indoor use. Specifically, I found it extremely interesting and revealing to discover that cooking fumes contribute to air pollution. I had never considered how various compounds and sources of air pollution carcinogens encompassed the entirety of what air pollution is beyond the surface-level knowledge that the burning of fossil fuels emits air pollution.

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[12] 1. “Cancer and Air Pollution,” UICC, accessed April 6, 2025, http://www.uicc.org/what-we-do/thematic-areas/cancer-and-air-pollution.

[13] 1. A J Cohen and C A Pope, “Lung Cancer and Air Pollution,” ehp.niehs.nih.gov, https://ehp.niehs.nih.gov/doi/abs/10.1289/ehp.95103s8219.

Since becoming significantly more aware of air pollutants and their harmful effects on humanity, I believe that making a difference in my life and encouraging others to adapt their ways of living is cardinal. Many small sustainable changes can be made in everyday life, and they may superficially seem small but still have an impact. The main sustainable change that I think people should be more aware of is fossil fuels and how driving habits contribute to the emission of carcinogens. Public transportation and alternative energy sources for vehicles have been on the rise as a way to implement sustainable alternatives that emit less air pollution. People have been increasingly voicing about using public transportation methods and creating more functional infrastructures in large cities that rely heavily on transportation.[14] This activism has helped educate the public and showed them ways to reduce their carbon footprint and the air pollution they contribute to. This can be done by carpooling, using public transportation, walking, and biking when possible. These individual daily human actions and conscious decisions aid in reducing the production of outdoor air pollutants because they decrease the number of carcinogenic compounds that enter the atmosphere. Other small changes can be made that may help at a smaller level within one's own home to minimize their omission and exposure to indoor air pollution. A few of the big ways to minimize air pollution in one's home are by properly ventilating household combustion products, booking inspections on central air systems and if broken getting then repaired, and checking for any issues or damages to protect the people of the house from carbon monoxide and also not smoking tobacco or nicotine products indoors.[15] By making these changes people are able to improve their quality of life and protect themselves and their families from carcinogens and their chances of developing lung cancer. Doing research into sustainable practices and making an effort to educate yourself on how your habits and lifestyle contribute to air pollution can help prevent the amount of hazardous particles and carcinogens that accumulate and cause air pollution.

The three scientific concepts I plan to incorporate into my creative final project are meant to explain the process of air pollution being emitted into the atmosphere, causing the carcinogens to spread and then being respirated by humans and infiltrating the lungs. The first scientific concept I will incorporate will cover how indoor and outdoor air pollution are produced from various human activities. I will provide evidence alongside examples of how pollutants and carcinogens enter the atmosphere. I will illustrate how indoor pollution most commonly

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[14] Nieuwenhuijsen, Mark J. “New Urban Models for More Sustainable, Liveable and Healthier Cities Post Covid19; Reducing Air Pollution, Noise and Heat Island Effects and Increasing Green Space and Physical Activity.” Environment International, September 13, 2021. http://www.sciencedirect.com/science/article/pii/S016041202100475X.

[15] 1. “Sources of Combustion Products,” EPA, accessed April 6, 2025, https://www.epa.gov/indoor-air-quality-iaq/sources-combustion-products.

originates from on-home activities, such as combustion products, pesticides, and radon, and how outdoor pollution differs in origins, which are mainly caused by the burning of fossil fuels, and the four forms they appear in, including physical, gaseous, chemical, or biological carcinogenic matter. The second scientific concept will focus on the different carcinogens and types of particulate matter that make up air pollution. I will differentiate them by discussing their specific origins. For indoor pollution, I will discuss the different specific combustion products, pesticides, and sources of radon and carbon monoxide. For outdoor pollution, I will differentiate the carcinogens, ground-level ozone, sulfur dioxide, nitrogen oxide, nitrogen dioxide, and all the volatile organic compounds. I will then transition into the third scientific concept that will explain what happens inside the respiratory system and narrate the process of each specific carcinogen. I will then explain the process of the carcinogens infiltrating the lungs, mutating the DNA, causing the formation of mutated cells, and finally causing lung cancer. I believe these three scientific concepts work well together and can be built on one another to tell a story that is scientifically accurate and informative.

The first direction I envision for my creative work is to create an informational stop-motion video. I would imagine the audience for the video to be people who are interested in learning why air pollution is so dangerous and destructive for them and encourage people to make personal efforts to contribute less to the contributing factors causing air pollution. To make the stop motion engaging for the viewer I will have the animator be a character that appears in each scene as he travels through each of the scientific concepts. Using storytelling, I plan to narrate the process of people producing air pollution, the air pollution spreading through the atmosphere, the carcinogens infiltrating the lungs, and lastly, causing respiratory system cells to die and become cancerous. I plan to have someone read a script that I will create. In the script, I will not only narrate what is happening in the animation but also provide facts and scientific reasoning for what is taking place. This way, the audience has visual senses to watch but is also being fed important information. Using Procreate, I would be able to create many drawings that would depict the knowledge and facts I learned from my research, covering all three of my scientific concepts. I plan to begin with a scenario of indoor and outdoor pollution entering the atmosphere in separate scenes. From there I intend to zoom into what the actual carcinogens and particulate matter are and discuss the different kinds and their origins. Next, I'll review what happens inside the lungs when the carcinogens enter the respiratory system. To end the stop motion on a positive note, I will propose ways that the viewer, along with larger populations of people, can make conscious efforts, decisions, and impacts to decrease the amount of hazardous cancer-causing carcinogens that enter the atmosphere.

The second direction I've considered for the creative aspect of my term project would be to create a collage. My audience for this piece would be a group of people who were interested in seeing activism art. My idea is to do a collage using various materials that will form a set of human lungs. To incorporate all three of my scientific concepts I would use materials, textures, and images to communicate with the viewer. To represent the different things that cause indoor pollution and outdoor pollution I would print out images of the origins of the carcinogens and cut them up to add to the collage. The main textural aspect I plan to focus on is the representation of carcinogenic particulate matter. When I imagine the particles I think of small circular objects. Using an assortment of beads I believe I would be able to represent the different types of pollutants while also adding texture to the piece and making it more interesting. Similarly to my first direction, I think I'd like to implement some sort of activism within the piece to also make a statement about air pollution and its effect on humans. I feel as though representing a lung unaffected by air pollution and another cancerous lung I would also be able to evoke strong emotion from the viewer and leave them with more of an impact. I plan to have the left lung represent the healthy clean lung and be full of warm colors that anatomically match what a real lung looks like. The materials I would use for this half of the collage would involve activism, sustainability, and the representation of a cancer-free healthy lung. On the other hand, the right lung will represent the cancerous lung. Using a palette of grays and other low-saturation colors I hope to portray the grossness and negative connotation that carcinogens have with human health. In the right lung, I will also include imagery and allude to the causes of air pollution, the forms of particulate matter, and how malignant lung tumors caused by air pollutants are formed. Another way I can create opposition between the two lungs is the composition and shape of the organ. For the healthy lung (the left lung) I will accurately mimic the shape of an anatomically accurate lung while also making the edges very apparent, giving the piece a smooth appearance. For the cancerous lung (the right lung) I will act more careless with my collaging and material placement, forcing the shape of the lung to be less accurate and more jagged and muddy. By doing this I hope to create chaos in the representation of the cancerous lung, further evoking fear and anxiety from the audience. My hope behind evoking these emotions is to give the audience motivation to change their habits to prevent themselves and others from getting lung cancer.

**Annotated Bibliography**

"Air Pollution and Lung Cancer: A Review by International Association for the Study of Lung Cancer Early Detection and Screening Committee - Journal of Thoracic Oncology." www.jto.org. Accessed April 7, 2025. https://www.jto.org/article/S1556-0864(23)00601-9/fulltext.

Factual information: Gaseous carcinogens include volatile organic compounds (VOCs), ground-level ozone ($O_3$), sulfur dioxide ($SO_2$), and nitrogen oxides (NOx). The carcinogens emitted by fossil fuels include sulfur dioxide and nitrogen oxides, specifically nitric oxide (NO) and nitrogen dioxide ($NO_2$). There are a few volatile organic compounds including aldehydes, ketones, aromatics, and other similar classes.

Conceptual information: There are many types of outdoor gaseous carcinogens and types of particulate matter that may cause lung cancer. It is important to understand each of these carcinogens because they're very different than each other, however they all still cause lung cancer.

Ali, M.U., P. Avino, R. Baan, K.J. Bai, J.R. Balmes, J.L. Barnes, M.H. Bourgault, et al. "Air Pollution: A Culprit of Lung Cancer." Journal of Hazardous Materials, April 15, 2022. http://www.sciencedirect.com/science/article/abs/pii/S0304389422007269.

Factual information: Air pollution can be classified into two main categories which are indoor air pollution or outdoor air pollution. Indoor air pollution originates from smaller-scale carcinogens that include smoke that comes from the burning and smoking of tobacco cigarettes, cooking fumes, and soot along with dangerous chemical compounds including benzene, radon, and formaldehyde. Outdoor air

pollutants may appear in four different forms. These forms include physical, gaseous, chemical, or biological carcinogenic matter.

Conceptual Information: Outdoor air pollution is a much broader category of air pollution and there are four origins the pollutants may stem from.

“Cancer and Air Pollution.” UICC. Accessed April 6, 2025. http://www.uicc.org/what-we-do/thematic-areas/cancer-and-air-pollution.

Factual Information: 43% of lung cancer deaths are caused by all forms of pollution and out of the 43%, 29% of these lung cancer deaths are caused by air pollution alone.

Conceptual Information: Ways to minimize the amount of outdoor air pollution that is emitted include prioritizing the reduction of air pollution in urban areas, promoting more sustainable transport options such as walking and biking, reducing vehicle emissions, and transitioning to clean energy sources, addressing indoor air pollutants such as solid fuels for cooking and healing, developing national air quality standards/regulations and establishing monitoring systems for air quality to track the progress to meet new standards.

Cohen, A J, and C A Pope. “Lung Cancer and Air Pollution.” ehp.niehs.nih.gov, 1AD. https://ehp.niehs.nih.gov/doi/abs/10.1289/ehp.95103s8219.

Factual information: It is unknown how many people in the US are exposed to respirable pollutants that have now been associated with lung cancer. There is a different rate of lung cancer patients in rural vs urban places and there is also increased lung cancer rate in people that live in urban areas.Specifically, combustion-source ambient air pollutants have been associated with causing lung cancer. Animal studies show how these combustion-source ambient air pollution can cause mutagenic or carcinogenic activity. The most alarming fact is that an increase in these cae-rcinogens has resulted in a 30% to 50% increase in the rate of lung cancer cases.

a. Combustion-source ambient air pollution is made up of combustion source particles which include the burning of:
    i. Tobacco
    ii. Coal
    iii. Diesel fuel

iv. Wood
v. Complex urban or industrial mixtures

Conceptual information: Outdoor and ambient air pollution is caused by the incomplete combustion of fossil fuels, which results in carcinogens entering the atmosphere. There is also epidemiologic evidence that proves air pollution caused by fossil fuels plays a large role in the growing rate of lung cancer cases.

"How Radon Gets into Your Home." Centers for Disease Control and Prevention. Accessed April 6, 2025. https://www.cdc.gov/radon/about/radon-home.html#:~:text=Radon%20is%20an%20odorless%20and,when%20its%20source%20is%20groundwater.

Factual information: Radon is a gas with the identifying qualities of being invisible and odorless.

Conceptual information: The best way to minimize your exposure to radon within your home is to maintain regular inspections to check for issues and damages that may cause radon to enter.

"Indoor Pollutants and Sources." EPA. Accessed April 6, 2025. https://www.epa.gov/indoor-air-quality-iaq/indoor-pollutants-and-sources.

Factual information: A huge percent of the indoor air pollution emitted in people's homes comes from combustion products.

Conceptual information: These carcinogens produced from the combustion products are a result of everyday human activities. When the combustion products are put to use they emit carcinogens that enter one's home without them even realizing.

Nieuwenhuijsen, Mark J. "New Urban Models for More Sustainable, Liveable and Healthier Cities Post Covid19; Reducing Air Pollution, Noise and Heat Island Effects and Increasing Green Space and Physical Activity." Environment International, September 13, 2021. http://www.sciencedirect.com/science/article/pii/S016041202100475X.

Factual information: There has been a recent increase in the encouragement to use more public/active transportation methods and limit the amount of private car use. By doing so there is a reduction in the amount of CO2 emissions. Urban planning and

designs for sustainability is used to work towards a better future where we can aid in minimizing air pollution and reducing CO2 emissions.

Conceptual information: There are current concepts and car free city models that use ideas of lowering carbon dioxide emissions. With this in mind professionals are able to develop ideas of what good infrastructure would look like in a city that relies heavily on transportation.

"Particulate Matter (PM) Basics." EPA. Accessed April 6, 2025. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#:~:text=Of%20these%2C%20particles%20less%20than,national%20parks%20and%20wilderness%20areas.

Factual information: Extremely hazardous particulate matter is identified when the particles have a diameter of 2.5 microns or less. The particles with a diameter of 2.5 microns or less are also referred to specifically as fine particulate matter. With this said particulate matter is still considered hazardous once its diameter reaches below 10 microns.

Conceptual information: Once particulate matter has a diameter of 10 micrometers or less the particles have the ability to penetrate deep inside the human lungs and even reach within the bloodstream. From there the particles have the ability to harm the DNA of cells and cause mutations.

"Pesticides' Impact on Indoor Air Quality." EPA. Accessed April 6, 2025. https://www.epa.gov/indoor-air-quality-iaq/pesticides-impact-indoor-air-quality.

Factual information: The five types of pesticides include termiticides, insecticides, rodenticides, fungicides and disinfectants.

Conceptual information: There are five kinds of pesticides that each differ from each other based on their uses and chemical makeup. Pesticides are harmful because they contain volatile organic compounds, which are a type of carcinogen that causes lung cancer.

“Sources of Combustion Products.” EPA. Accessed April 6, 2025. https://www.epa.gov/indoor-air-quality-iaq/sources-combustion-products.

Factual information: Combustion products found in homes include wooden stoves, gas stoves, fireplaces, gas powered space heaters and unvented kerosene. These combustion products then emit carbon monoxide, nitrogen dioxide and particulate matter into one's home.

Conceptual information: The main way to minimize the chances of combustion products emitting carcinogens is by properly ventilating household combustion products. By implementing a ventilation system you're able to minimize your exposure to these carcinogens because they are wafted out of your home and cannot wait around to be breathed in by the people living there.