Air Particles Linked to Cell Damage

An L.A.-area study finds the tiniest pollutants disrupt basic cellular functions, likely causing a host of diseases.
By Gary Polakovic
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A team of Southern California researchers has discovered that microscopic airborne particles can disrupt the inner mechanics of cells, offering a possible explanation of how air pollutants common in urban haze can harm the human body.

The new study, led by scientists at UCLA and USC, links the most minuscule particles found in dust and smoke to injuries. The particles are so small -- about 1,000 could fit inside the period at the end of this sentence -- that they easily bypass the body's defense mechanisms.

The findings also are the first to show that very tiny particles travel beyond the lungs and bloodstream to penetrate deep inside cells. The pollutant accumulates within a critical component that powers the cell and maintains its function. Damage to that cellular component is known to lead to an assortment of diseases.

The study is scheduled to be published this week in the journal Environmental Health Perspectives, a publication of the National Institute of Environmental Health Sciences, and is currently available on the journal's Internet home page.

Researchers have long known that haze over major cities causes a wide range of health problems. Numerous studies worldwide have linked particle pollution to school absences, hospital admissions, shortened life spans, reduced lung function, heart disease and cancer. The U.S. Environmental Protection Agency established rigorous standards for curbing particle pollution in 1997. The agency estimates that those rules will prevent 15,000 premature deaths, 350,000 cases of asthma and 1 million cases of lung problems in children by the year 2020.

But researchers have been unsure what types of particles were to blame for the health effects.

"We have had no idea of the biological potency of different size particles in the air," said UCLA researcher Andre Nel, a physician and lead author of the study. The new research "may be a mechanism to explain how the smallest particles cause adverse health effects," he said.

Particulate matter turns the sky gray with gauzy haze, limiting visibility. It consists of microscopic bits, ranging from pulverized tire fragments to diesel soot to acid droplets, and is measured in microns, a unit equivalent to a millionth of a meter. A human hair is about 50 microns across.

Currently, environmental regulations try to limit particles that are 10 microns in diameter and smaller particles in the 2.5-micron range. But the particles that caused the most damage in the new study are one-tenth of a micron across.

[Dust and smoke are made of particles of about 10 microns. The smallest particles come mainly from burning fossil fuels.] *Burning Issues comment. This is incorrect: -all combustion processes including wood burning yeild particulates in the range of smaller than 2.5 microns. In fact Larson and Koineg have stated that 90% of wood smoke particles are smaller than .1 micron.* Those tiny particles float in the air longer, travel farther and are more easily inhaled than larger ones.

The Los Angeles Basin ranks as one of the worst places in the nation for particle pollution. The highest concentrations typically occur in western Riverside County. But the Los Angeles-Long Beach area has more of the tiny particles emitted by vehicle exhaust. Using the region as a laboratory, the EPA established one of five national particle-pollution research centers at UCLA, which produced the latest study.

In their study, the team of 10 scientists collected particles in various sizes from air above Claremont and the USC campus near downtown Los Angeles between November 2001 and March 2002. The pollution was concentrated, put into solution and added to two types of cells.

One group of cells included macrophages taken from mice. A macrophage is a type of cell that scavenges and destroys foreign matter in the lung and other organs. The other cells were taken from the lining deep inside a human lung. The scientists then measured chemical reactions in the tissues and examined the cells with an electron microscope.

The researchers found that when the particles come in contact with the cells, they trigger a reaction that causes inflammation. That may help explain how particle pollution exacerbates asthma, an inflammation of the airways, Nel explained.

Deeper inside the cells, researchers found that the one-tenth-of-a-micron particles accumulated inside cell structures called mitochondria. Oblong in shape, mitochondria are the workhorses of cells. They combine sugar and oxygen to produce the fuel that keeps cells running.

The study shows that the pollution damaged the shape of mitochondria, causing them to stop producing the cellular fuel and start producing other chemicals, which lead to more inflammation and cell damage.

Melanie Marty, chief of air toxicology and epidemiology at the California Office of Environmental Health Hazard Assessment, said the findings highlight the danger of the smallest particles, which have not been the focus of regulations of air pollution. She did not work on the research, but is familiar with the paper.

"The mitochondria of a cell is like a cell's battery. Once you damage the mitochondria, you're going to kill the cell," Marty said. "This shows the ultra-fine particles are better at causing damage, and we should be paying more attention to ultra-fine particles because of their toxicity and ability to produce this stress in the cell."

The study comes with some limitations. Scientists examined pollutants at just two locations in the Los Angeles region. Particle pollution varies by concentration and type across cities.

Also, the pollution that the cells were exposed to in the study is more concentrated than what is typically found in ambient air. The researchers cautioned that their observations come from the laboratory and that more studies are needed to see if similar results occur in people or animals exposed to less-concentrated pollution.

Fernando Scaglia, a professor in the department of molecular and human genetics at Baylor College of Medicine in Houston who has read the paper, said damage to mitochondria in cells can lead to various diseases, including Parkinson's and Alzheimer's, as well as strokes and other neurological impairment. Damage to mitochondria, he said, can increase over time as cells divide, leading to a breakdown of cell function and early onset of disease.

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