Role of Nanoparticles in Air Pollution

Why in news?

New research has raised concerns over the dangerous effects of air pollution, as toxic pollutants have been found in the developing lungs and other vital organs of unborn babies.

What are nanoparticles?

- **Size** - Nanoparticles (NPs) are tiny particles between 1 and 100nm.
- Due to their ultrafine size, they can be suspended in the atmosphere for a long time and can travel larger distances.
- **Mass** - They possess very little mass but are many in number.
- So, the current mass-based, ambient air quality regulations for particulate matter are ineffective in dealing with nanoparticle concentrations in cities.
- **Source** - Nanoparticles enter the environment from various sources, including natural, incidental and manufactured processes.

Road vehicles contribute up to 90% of the total in polluted environments.

What is the role of nanoparticles in air pollution?

- **Global climate** - Unlike their larger-sized soot particles (black carbon), nanoparticles can be activated as cloud droplets.
- High concentrations of these droplets increase the proportion of solar radiation reflected back to space, causing a cooling effect on climate.
- **Health effects** - Long exposures to high concentrations of nanoparticles cause lung problems and cardiovascular disease.
- One of the key reasons for their negative health impact is their toxicity and large total surface area per unit mass.
- This increases their potential chemical reactivity and ability to be absorbed.
- They can pass deep into the respiratory system, reacting with the lung tissues and potentially entering the bloodstream.
- Infant mortality, neonatal complications and birth defects are likely to increase with increasing concentrations of matter smaller than 10 µm.
- As per a recent study, the number of **black carbon** particles that enter the mother is passed on proportionally to the baby.

According to the Lancet Planetary Health report, India recorded the largest number of deaths related to air pollution than any other nation in 2019.

Why nanoparticles are usually not talked about?

- Evidence on the toxic effects of nanoparticles on human health is insufficient.
- The chemically reactive nature of nanoparticles makes the risk assessment highly uncertain.
- There is no mechanism available to record the extent of air pollution arising from nanoparticles.
    - The Central Pollution Control Board has the facility to monitor only PM2.5/PM10 pollutants in Delhi or elsewhere.
- There is insufficient knowledge of the physical and chemical characteristics of nanoparticles from new sources such as those produced by vehicles run on bio-fuels.

What is the need of the hour?

- Combustion can be replaced with electrification as electric cars do not emit combustion-derived nanoparticles.
- There is a need for the government to raise awareness on the dangers of nanoparticles.
- Monitoring stations should make an effort to measure the extent of air pollution arising from nanoparticles.

References

1. The Hindu Businessline | Air pollution is not just about PM10 and PM2.5
2. The Conversation | Nanoparticles in air pollution
3. India Today | Toxic air pollutants found in lungs, brains of unborn babies
4. Climate and Clean Air Coalition | Black carbon

Quick facts

Black carbon

- Black carbon, or soot, is part of fine particulate air pollution (PM2.5).
- It is formed by incomplete combustion of fossil fuels, wood and other fuels.
- **Features** - Black carbon is a short-lived climate pollutant with an average atmospheric lifetime of 4-12 days.
- Black carbon has a warming impact on climate 460-1,500 times stronger than CO_2 per unit of mass.
- **Source** - Household cooking and heating account for 51% of global black carbon emissions.
- **Impacts** - Black carbon is an important contributor to warming because it is very effective at absorbing light and heating its surroundings.
- When deposited on ice and snow, black carbon particles reduce surface albedo (the ability to reflect sunlight) and heat the surface, thus leading to melting.
- Black carbon and its co-pollutants are key components of PM2.5 air pollution, the

leading environmental cause of poor health and premature deaths.

- Black carbon can affect the ecosystem's health by depositing on plant leaves and increasing their temperature, dimming sunlight that reaches the earth, and modifying rainfall patterns.

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