Three links you need to know

Connect each source or agent to an exposure route and a health outcome. Sewage can carry infectious agents; asbestos and ozone cause noninfectious harm.

1. UNTREATED SEWAGE → DYSENTERY

Sewage contaminates water → Pathogens enter by ingestion → Intestinal infection

Untreated sewage in rivers and streams can introduce fecal pathogens. Swallowing contaminated water can cause dysentery, an intestinal illness involving bloody diarrhea. Shigella bacteria are one possible cause; sewage is the carrier, not the infectious organism itself.

2. ASBESTOS → MESOTHELIOMA

Fibers released into air → Fibers are inhaled → Cancer risk increases

Disturbing asbestos-containing material can release airborne fibers. Asbestos exposure is the main risk factor for mesothelioma, a cancer of the lining around organs such as the lungs. Disease can appear decades after exposure; it is not an infection.

3. TROPOSPHERIC OZONE → RESPIRATORY HARM

Ground-level ozone in air → Ozone is inhaled → Airway irritation; lower lung function

Elevated ground-level ozone can inflame airways, cause coughing or breathing discomfort, reduce lung function and worsen asthma. Healthy people can also be affected. Ozone is a reactive gas, not a pathogen.

Keep the agents distinct: fecal pathogens cause infection; asbestos fibers are carcinogenic; ozone damages respiratory tissues.

Water contamination and Shigella: CDC, Germs That Can Contaminate Tap Water.
Asbestos and mesothelioma: National Cancer Institute, Asbestos Exposure and Cancer Risk.
Respiratory effects: US EPA, Health Effects of Ozone Pollution.

Scope: College Board AP Environmental Science CED, Topic 8.14, p. 173.

Exposure is more than location

Supporting context: finding a pollutant nearby does not tell you how much reaches a person. Trace the route, duration and conditions of contact before describing risk.

1. FOLLOW THE EXPOSURE PATHWAY

SOURCE	→	MEDIUM	→	ENTRY ROUTE	→	RESPONSE
Where the agent originates		Air, water, food or dust		Inhalation or ingestion		An effect in the body

Consider the concentration encountered, time and frequency of contact, and individual susceptibility. The same outdoor air concentration need not produce the same inhaled dose: physical activity increases breathing.

2. SHORT-TERM EFFECTS AND DELAYED DISEASE

Ozone can affect breathing after short-term exposure, especially during outdoor exertion. Children, active outdoor workers and people with asthma can be particularly affected. In contrast, asbestos-related cancers may emerge decades after the exposure. A long delay can make an old exposure history important even when present-day conditions look different.

3. OZONE: THE LOCATION CHANGES ITS ROLE

Tropospheric ozone is a secondary pollutant formed when nitrogen oxides and volatile organic compounds react in sunlight. It can be transported downwind, so the place affected need not be the place emitting its precursors. Stratospheric ozone helps absorb ultraviolet radiation; that protective role does not make ozone safe to breathe near the ground.

Prevention link: sewage treatment and safe drinking water interrupt pathogen exposure; controlling airborne asbestos fibers and ozone precursors addresses different hazards. Match the intervention to the pathway.

Exposure and susceptibility: US EPA, Conducting a Human Health Risk Assessment.
Ozone effects and susceptible groups: US EPA, Health Effects of Ozone Pollution.
Ozone formation and transport: US EPA, Ground-level Ozone Basics.
Delayed asbestos-related disease: National Cancer Institute, Asbestos Fact Sheet.

Scope: College Board AP Environmental Science CED, Topic 8.14, p. 173.

Why cause and effect can be hard

People encounter mixtures of pollutants, not one isolated chemical. Research must distinguish a pollutant effect from other factors that could explain an observed health pattern.

1. SEPARATE ASSOCIATION FROM CAUSATION

An association means exposure and a health outcome vary together. It does not, on its own, establish the cause. Co-exposures, smoking, occupation, age, existing illness and long disease latency can complicate interpretation. Researchers combine exposure measurements, health records, timing and biological evidence to assess possible explanations.

2. AN OBSERVATIONAL STUDY: OZONE AND BREATHING

Illustrative research design, not a report of actual findings.

Measure exposure	Record outdoor ozone concentrations and time spent outdoors.
Measure response	Use consistent lung-function measurements and symptom records.
Make comparisons	Follow the same consenting participants across lower- and higher-ozone days.
Check other factors	Record temperature, pollen, particles, activity and asthma status; account for them in the analysis.

Observe normal conditions; do not deliberately expose participants to harmful pollution for a classroom investigation.

3. STATE A CONCLUSION THAT MATCHES THE EVIDENCE

Suppose poorer lung function occurs on higher-ozone days. This supports an association with ozone exposure, but one observational study alone does not eliminate all alternative explanations. Repeated findings, appropriate comparisons and a plausible mechanism strengthen a causal case.

Difficulty identifying one person's cause does not mean pollution is harmless: the sewage, asbestos and ozone links on page 1 are established health concerns.

Mixed exposures and attribution: College Board APES CED, EIN-3.C.1.
Epidemiology, exposure and evidence: US EPA, Conducting a Human Health Risk Assessment.

Scope: College Board AP Environmental Science CED, Topic 8.14, p. 173.