

The Environment and Human Health

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The Environment and Human Health provides an introduction to environmental health science, a field of study that investigates how the environment influences human health and disease.

Image Reference

Microsoft Office ClipArt

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Fire boat response crews battle the blazing remnants of the offshore oil rig, Deepwater Horizon. This disaster, documented by a Coast Guard MH-65C dolphin rescue helicopter and crew, is an example of a catastrophic event in which the environmental and health impacts are evident immediately.

Image Reference

US Coast Guard. (2010). Deepwater horizon fire (100421-G). Retrieved 10-25-2010, from http://commons.wikimedia.org/wiki/File:Deepwater_Horizon_offshore_drilling_unit_on_fire_2010.jpg.

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Some environmental health issues that seem small-scale actually have large global impacts. For example, the cooking fires used by individual households in many parts of the world may seem minor and localized. But worldwide, exposure to cook stove smoke kills nearly two million people each year (according to the Global Alliance for Clean Cookstoves). It also doubles a child's risk of contracting pneumonia. Furthermore, cooking smoke gives off particulates and greenhouse gases that contribute to global warming.

In developing countries, girls may spend as many as 20 hours per week collecting fuel for cooking. This relentless search for cooking fuel is causing deforestation in many areas of the world. Deforestation, in turn, leads to changes in rainfall patterns and run-off, and accelerates soil erosion and loss of soil fertility. All of these outcomes have negative impacts on human health.

Image Reference

Hannaway F. (2010). Collecting firewood in Basankusu. Retrieved 10-25-2010, from http://commons.wikimedia.org/wiki/File:Basankusu_collecting_firewood_by_Francis_Hannaway.jpg.

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Environments Influence Human Health and Disease

- Natural environment (air, water, soil), including chemical, biological and social features of our surroundings
- Man-made, or “built,” environment (buildings, roads/transportation systems, land use practices, pollution and waste management)
- Social environment (diet and exercise, socioeconomic status and other societal influences)
- Environment interacts with a person’s genetic make-up.



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Environmental health is the field of science that studies how the environment influences human health and disease. “Environment” in this context can include any or all of the following.

1. The natural environment, including air, water and soil; and also the physical, chemical, biological and social features of our surroundings.
2. The man-made, or “built,” environment, such as physical structures where people live and work (e.g., homes, offices, schools, farms and factories); community systems, such as roads and transportation systems; land use practices and waste management. Human alterations of the natural environment, such as through air pollution, are also considered part of the man-made environment.
3. The social environment, encompassing lifestyle factors like diet and exercise, socioeconomic status, and other societal influences that may affect health.
4. Environmental interaction with a person’s genetic make-up, which can shift the balance between disease and health.

Reference

National Institutes of Health, US Department of Health and Human Services. *What Is Environmental Health?* National Institute of Environmental Health Sciences (www.niehs.nih.gov).

Image Reference

MS PowerPoint clipart

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Environmental Health

- Defined by the problems faced.
- Uses a systems approach to understand a problem; usually focuses on populations.
- Includes any aspect of the environment.
 - Chemicals
 - Pests
 - Infectious diseases
 - Radiation
 - Noise
 - Temperature



House Dust Mite
(*Dermatophagoides pteronyssinus*)



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In many cases, environmental health issues are identified when it is noticed that a particular health problem is occurring at a higher-than-normal rate in a particular population. Sometimes, these health concerns are related to exposure to toxic chemicals in air, water, food, soil, or built environments. However, other elements within the environment also can have adverse effects on human health. For example, pests, such as dust mites, can cause allergies and contribute to asthma; and mosquitoes can carry infectious diseases like malaria and dengue fever. Additional environmental factors, such as water contaminated with bacteria, also contribute to infectious diseases. Radiation from the sun or from our homes (radon) can cause cancer. Noise pollution leads to hearing loss. Even fluctuations in temperature can affect health dramatically, and on a large scale. Consider global climate change: increased temperatures in some parts of the world are causing the ranges (or vectors) of certain disease-causing organisms to expand and infect new populations.

Image Reference

House dust mite. (2006). Retrieved 11-05-2010, from http://en.wikipedia.org/wiki/File:House_Dust_Mite.jpg.

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The Dose Makes the Poison

- *All substances are poisons; there is none which is not a poison. The right dose differentiates a poison....* (Paracelsus, 1493-1541)
- Toxicologists study poisons (any substance that causes a harmful effect to living organisms).



Photo courtesy
National Library of
Medicine



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Toxicology is the branch of science that studies the effects of poisons on living organisms. And there is a lot to study, because too much of any substance can cause harm. In the 1500s, the Swiss physician, Paracelsus, accurately observed that the “dose,” or amount of exposure, to a toxin determines whether the toxin will have a harmful effect, and how severe the effect will be. “Dose” refers specifically to the amount of a substance that is eaten, inhaled or absorbed through the skin. Obviously, rapid exposure to large amounts of toxins, such as after a major chemical spill, can be harmful. But exposure to relatively low doses of chemicals or radiation over long periods of time also can contribute to the development of disease.

Image Reference

United States, National Library of Medicine, National Institutes of Health. Title page from one of National Library of Medicine's acquired works by Paracelsus (Paracelsus, *Vom ursprung und herkommen des Bads Pfeffers*, Basel, 1576). Retrieved 11-05-2010, from <http://www.nlm.nih.gov/exhibition/paracelsus/collections.html>.

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We Live in a Chemical World

- More than 70,000 potentially toxic chemicals are produced and dispersed.
- Chemicals have many effects.
 - Contribute to atmospheric change.
 - Contaminate surface and groundwater.
 - Affect species balances and natural cycles in ecosystems.
 - Mimic hormones.
 - Cause mutations in genes.
 - Affect the nervous system.



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Courtesy of JP Denk

Many environmental health problems arise from chemical exposures. Some chemicals have immediate poisonous effects, while others cause problems only after multiple cumulative exposures. In addition to affecting the health of individuals, chemicals can impact entire populations of humans and other organisms by causing changes to the land (e.g., increased soil salinity due to irrigation), water (e.g., increased water temperature near nuclear power plants), and/or air (e.g., climate change brought on by increases in greenhouse gas emissions). These changes impact food webs and ecosystems deeply. For instance, they may cause alterations in the range of some disease-causing animals, thereby leading to the spread of diseases into new regions of the world.

Radiation and certain small molecules alter the DNA sequence within cells. Changes caused by these agents, called mutagens, can lead to cancers and other genetic disorders.

Some chemicals in the environment, particularly pesticides, have been linked to the development of Parkinson's disease, a progressive brain disorder.

Other chemical substances, known as endocrine disruptors or environmental

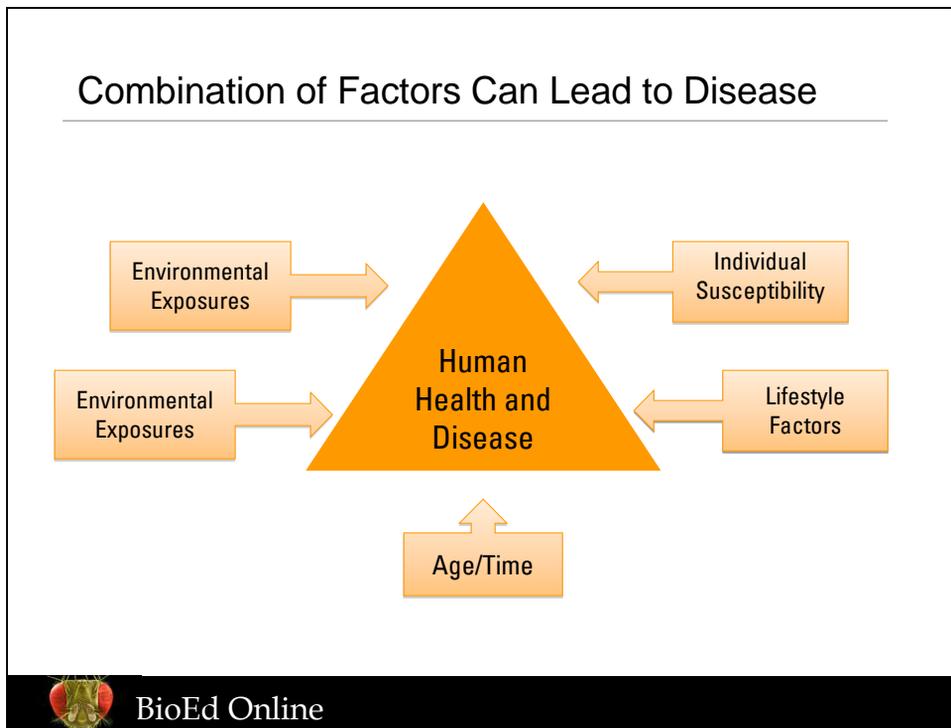
estrogens, affect hormone balance and/or interfere with normal functioning of hormones within the body. Most can bind to hormone-specific receptors on the cells of target organs within the body. Endocrine disruptors include man-made chemicals, such as pesticides and plasticizers; natural chemicals found in plants (phytoestrogens); pharmaceuticals; and hormones excreted in animal or human waste.

Image Reference

Denk, JP. (2007). Page Arizona 009. JP Denk Photo. Retrieved 01-20-2011 from http://www.jpdenkphoto.com/gallery/usa/az_page_009.html

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Almost all diseases result from a complex interaction between an individual's genetic make-up and environmental agents. Subtle genetic differences can cause people to respond differently to the same environmental exposure. This explains why some individuals have a fairly low risk of developing a disease after being exposed to a given environmental toxin/agent, while others are much more vulnerable.

The dose and timing of exposure also are important. Sometimes, diseases that are linked to the environment may take many years to develop after the time or times of exposure. Lifestyle factors, such as diet, exercise and maintaining an appropriate body weight, also may influence one's susceptibility to disease.

Reference

National Institutes of Environmental Health Science. Gene-environment interaction. Retrieved 11-05-2010, from <http://www.niehs.nih.gov/health/topics/science/gene-env/index.cfm>.

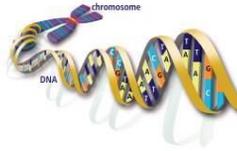
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Gene Variations Affect Susceptibility

- Environment can trigger disease development.
 - Age and gender also play a role.
 - Parkinson's Disease is an example.
- Some environmental agents cause mutations that affect how cells function.
 - Chemicals
 - Radiation
 - Infectious agents
- Environmental agents also can affect the activity of genes (gene expression).



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Many diseases are the outcome of a complex inter-relationship between multiple genetic and environmental factors. Research suggests that individual susceptibility to a given disease is influenced more by certain genes than by exposure to environmental agents. The Environmental Genome Project, for example, is working to characterize how certain human genetic variations contribute to the likelihood that a given individual will be susceptible to an environmentally induced disease.

Each person has two copies of genetic material, or genes—one set from each parent. Genes are specific sequences of bases that encode instructions for making proteins. Changes in one or both copies of a gene can confer greater or less susceptibility to harm from an environmental exposure.

Toxins in the environment can trigger development of disease. In addition, combinations of the effects of several to many genes determine whether a person actually will become ill. Age, gender, and dose and timing of exposures also influence the development of diseases with an environmental component.

Some chemicals, radiation and even infectious agents, such as viruses, can cause gene mutations (permanent changes in the DNA sequence) that affect

cell function. Sometimes, these mutations lead to the development of various kinds of cancer over time.

Many researchers are working to identify groups of genes that confer protection and/or greater risk of harmful effects from environmental exposures.

Image Reference

U.S. Department of Energy Genome Programs. DNA with features (Genome Management Information System, Oak Ridge National Laboratory). Retrieved 11-05-2010, from <http://genomics.energy.gov>.

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Susceptible Groups

- Poor and minority communities
 - Neighborhoods are more likely to be closer to pollution sources.
 - Housing may have more contaminants, such as lead or asthma triggers.
 - Limited access to health care
- Children
 - Take in more air, food, and water per unit of body weight than do adults.
 - Still developing, so more vulnerable
 - More years to develop disease



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Poor and minority communities are more likely than others to be located in less desirable locations, closer to pollution sources and other environmental hazards. Poor quality housing may have lead-based paints, which are toxic; and/or insects or mold that can trigger allergies and asthma in susceptible individuals. In addition, low income groups may have reduced access to preventive health care and treatment.

Children are particularly vulnerable to environmental contaminants. Because children take in more air, food and water, per unit weight, than adults do, they have greater exposure, proportionately, to toxins than do adults. In addition, children's developing nervous, respiratory, reproductive and immune systems are more susceptible to damage than are fully developed systems in adults.

Children's behaviors also can put them at greater risk. They generally spend more time outdoors than adults do, are more likely to ingest toxicants (such as paint chips) through hand to mouth contact, and breathe more air per pound of body weight than adults do. Finally, children have longer life spans over which to develop disease than do adults.

Reference

Children's Environmental Health Network. (2010). An introduction to children's environmental health. Retrieved 11-05-2010, from http://www.cehn.org/education/what_is_ceh.

Image Reference

Microsoft Office ClipArt

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Indoor Air Pollution and Asthma

- Asthma affects 6.2 million children.
- Asthma prevalence is increasing, even though outdoor air quality is improving.
- Modern children's under-utilized immune systems may over-react to allergens.
- Non-seasonal allergens and asthma irritants include cigarette smoke, cockroaches, dust mites, mold, pets and pollen.



Photo: Wikimedia Commons, João Estevão A. de Freitas



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Asthma is a lung disease that can cause inflammation and narrowing along the entire airway, from the nose to the lung. When the airway becomes swollen and inflamed, it grows narrower, allowing less air through to the lung tissue. This causes symptoms such as wheezing, coughing, chest tightness, and difficult breathing.

Once considered a minor ailment impacting only a small portion of the population, asthma is now the most common chronic disorder of childhood, and it affects an estimated 6.2 million children in the US under the age of 18. Asthma runs in families, suggesting that genetic factors may play a role in the development of this disease. However, environmental factors also contribute to the disease process, and asthma can be triggered by a wide range of substances, called allergens.

Reference

National Institutes of Environmental Health Sciences. (2010). Asthma. Retrieved 11-05-2010, from <http://www.niehs.nih.gov/health/topics/conditions/asthma/index.cfm>.

Image Reference

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Climate Change Affects Health

- Environmental effects
 - Weather changes and extremes
 - Ecosystems
 - Water scarcity and/or flooding
 - Oceans and coastal regions
 - Air quality
- Disease concerns (examples)
 - Food- and water-borne illnesses
 - Asthma, allergy and airway diseases
 - Infectious diseases carried by animals
 - Cancer, cardiovascular and neurological diseases



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Climate change directly affects many aspects of the environment including water resources (drought or flooding) air quality, weather changes, oceans and coastal regions, and the composition and functioning of ecosystems. Changes in rainfall, other precipitation and temperatures, and the melting of summer ice caps are, and will continue to alter the availability and quality of water across much of the planet over the next 30 years. In the United States, water security—the reliable availability of water for drinking, agriculture, manufacturing, and myriad other uses—is becoming a pressing issue.

The complex atmospheric chemistry that governs air quality is modulated by heat, humidity, degree of ultraviolet (UV) radiation, and many other factors. Changes in any of these elements can directly reduce air quality, particularly in urban areas, by increasing concentrations of, and human exposure to a variety of toxic air pollutants, including chemicals, fungi and aeroallergens. In many parts of the US, climate change and the resulting weather events, such as drought and wildfires, will reduce general air quality, elevate human exposure to a variety of pollutants, and give rise to an increased incidence of asthma, cardiovascular disease, and many respiratory ailments.

Some human health effects associated with climate change will result from extreme weather events, which are expected to become more common in a warmer climate. For instance, more intense hurricanes and increases in flooding and wildfires may exacerbate a wide range of health effects resulting

from the release of toxic chemicals from landfills, the contamination of drinking water with raw sewage due to an aging and damaged water infrastructure, higher concentrations of air pollutants that are especially harmful to susceptible populations (particularly children and the elderly), and many other hazards.

Global climate change is visibly and profoundly affecting oceans, which in turn, affect human health. The warming of ocean waters worldwide contributes to increased incidence and severity of toxic algal blooms, alterations in aquatic and estuarine food webs, reduction of seafood quality/availability, and threats to sentinel aquatic species.

Climate changes, including hotter temperatures in certain arid and semi-arid parts of the United States, can dramatically alter existing ecosystems, thereby creating new challenges for agricultural producers and coastal ecosystems that can have serious consequences for food quality and availability. Changes in plant habitat can reduce the availability of grazing lands for livestock.

Climate change also is directly associated with many pest habitats and disease vectors. Fluctuating temperatures can extend or reorient habitats to the point that pests are introduced to new geographic areas. In some cases, life cycles may be altered, thereby requiring increased use of pesticides, and/or use in new areas. Global warming is causing shifts in the ranges of disease vectors that require specific environments to thrive (for example, Lyme disease). Such shifts increase the threat and incidence in humans of waterborne, vectorborne and zoonotic (transferred from animals to humans) diseases.

Image Reference

National Institute of Environmental Health Sciences. (2010). *A human health perspective on climate change: A report outlining the research needs on the human health effects of climate change*. Retrieved 1-20-2011 from <http://www.niehs.nih.gov/health/docs/climatereport2010.pdf>

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Disruptions of the Endocrine System

- Some chemicals in everyday products interfere with the endocrine system and production of hormones.
 - Pharmaceuticals
 - Dioxins
 - Polychlorinated biphenyls (PCBs)
 - DDT and other pesticides
 - Bisphenol A (BPA)
- Health problems
 - Early onset of puberty in girls, and other developmental problems
 - Obesity



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The endocrine system produces chemical messengers that regulate many life processes, including sexual development, metabolic functions, development of the brain, growth, and the response to stress. Endocrine disruptors are chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife.

A wide range of substances, both natural and man-made, are thought to cause endocrine disruption: pharmaceuticals, dioxin and dioxin-like compounds, polychlorinated biphenyls, DDT and other pesticides, and plasticizers, such as bisphenol A. Endocrine disruptors may be found in many everyday products, including plastic bottles, metal food cans, detergents, flame retardants, food, toys, cosmetics, and pesticides. Some endocrine disruptors are so similar to hormones produced by the body that they can occupy the same sites in the body, and produce the same responses as hormones manufactured by the body.

Reference

National Institute of Environmental Health Sciences. *Endocrine disruptors*. Retrieved 11-05-2010, from <http://www.niehs.nih.gov/health/topics/agents/endocrine/index.cfm>.

Image Reference

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Environmental Health Education from BioEd Online and K8 Science

- Lessons and complete units (Indoor Air; Water; Global Atmospheric Change; Food, Nutrition and Food Safety)
- Professional development
 - Short courses
 - Video lesson and content presentations (downloadable slides)
- Supplementary materials for students
 - Mini-magazines
 - Reading and math links
 - Adventure stories



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The My Health My World and ECOS projects at Baylor College of Medicine have developed teaching materials that focus on basic science and environmental health concepts related to air quality, water quality, global atmospheric change and food safety and nutrition. These materials are available, free of charge, on the BioEd Online and K8 Science websites.

Image Reference

Center for Educational Outreach, Baylor College of Medicine. *My Health My World* book cover. Baylor College of Medicine: Houston, TX.

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