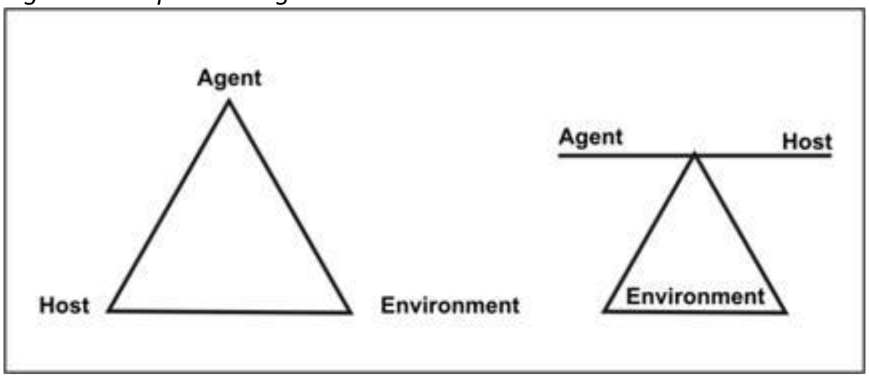
Concepts of Disease Occurrence (1.8)

A critical premise of epidemiology is that disease and other health events do not occur randomly in a population, but are more likely to occur in some members of the population than others because of risk factors that may not be distributed randomly in the population. As noted earlier, one important use of epidemiology is to identify the factors that place some members at greater risk than others.

Causation

A number of models of disease causation have been proposed. Among the simplest of these is the epidemiologic triad or triangle, the traditional model for infectious disease. The triad consists of an external **agent**, a susceptible **host**, and an **environment** that brings the host and agent together. In this model, disease results from the interaction between the agent and the susceptible host in an environment that supports transmission of the agent from a source to that host. Two ways of depicting this model are shown in Figure 1.16.

Figure 1.16 Epidemiologic Triad



One model shows agent, host, and environment as having equal influence. The other model shows agent and host as variables that are dependent on each other and on the environment.

Agent originally referred to an infectious microorganism or pathogen: a virus, bacterium, parasite, or other microbe. Generally, the agent must be present for disease to occur; however, presence of that agent alone is not always sufficient to cause disease. A variety of factors influence whether exposure to an organism will result in disease, including the organism's pathogenicity (ability to cause disease) and dose.

Over time, the concept of agent has been broadened to include chemical and physical causes of disease or injury. These include chemical contaminants (such as the L-tryptophan contaminant responsible for eosinophilia-myalgia syndrome), as well as physical forces (such as repetitive mechanical forces associated with carpal tunnel syndrome). While the epidemiologic triad serves as a useful model for many diseases, it has proven inadequate for cardiovascular disease, cancer, and other diseases that appear to have multiple contributing causes without a single necessary one.

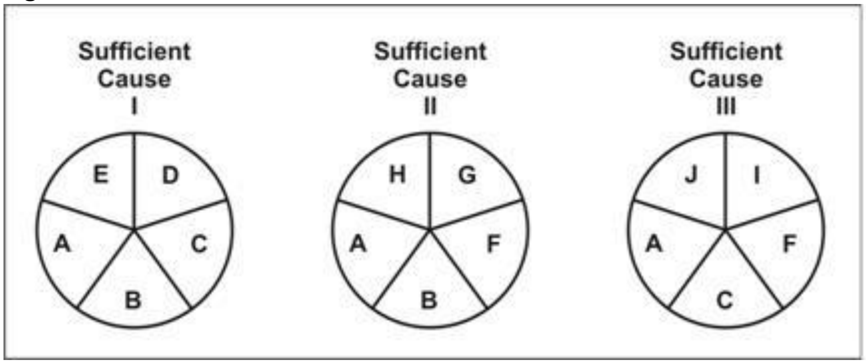
Host refers to the human who can get the disease. A variety of factors intrinsic to the host, sometimes called risk factors, can influence an individual's exposure, susceptibility, or response to a causative agent. Opportunities for exposure are often influenced by behaviors such as sexual practices, hygiene, and other personal choices as well as by age and sex. Susceptibility and response to an agent are influenced by factors such as genetic composition, nutritional and immunologic status, anatomic structure, presence of disease or medications, and psychological makeup.

Environment refers to extrinsic factors that affect the agent and the opportunity for exposure. Environmental factors include physical factors such as geology and climate, biologic factors such as insects that transmit the agent, and socioeconomic factors such as crowding, sanitation, and the availability of health services.

Component causes and causal pies

Because the agent-host-environment model did not work well for many non-infectious diseases, several other models that attempt to account for the multifactorial nature of causation have been proposed. One such model was proposed by Rothman in 1976, and has come to be known as the Causal Pies. This model is illustrated in Figure 1.17. An individual factor that contributes to cause disease is shown as a piece of a pie. After all the pieces of a pie fall into place, the pie is complete — and disease occurs. The individual factors are called **component causes**. The complete pie, which might be considered a causal pathway, is called a **sufficient cause**. A disease may have more than one sufficient cause, with each sufficient cause being composed of several component causes that may or may not overlap. A component that appears in every pie or pathway is called a **necessary cause**, because without it, disease does not occur. Note in Figure 1.17 that component cause A is a necessary cause because it appears in every pie.

Figure 1.17 Rothman's Causal Pies



Causal pies are pie charts with each component cause as a slice. Slice A is in each pie. Slice B is only in pies 1 and 2. Slice C is only in pies 1 and 3.

The component causes may include intrinsic host factors as well as the agent and the environmental factors of the agent-host-environment triad. A single component cause is rarely a sufficient cause by itself. For example, even exposure to a highly infectious agent such as measles virus does not invariably result in measles disease. Host susceptibility and other host factors also may play a role.

At the other extreme, an agent that is usually harmless in healthy persons may cause devastating disease under different conditions. *Pneumocystis carinii* is an organism that harmlessly colonizes the respiratory tract of some healthy persons, but can cause potentially lethal pneumonia in persons whose immune systems have been weakened by human immunodeficiency virus (HIV). Presence of *Pneumocystis carinii* organisms is therefore a necessary but not sufficient cause of pneumocystis pneumonia. In Figure 1.17, it would be represented by component cause A.

As the model indicates, a particular disease may result from a variety of different sufficient causes or pathways. For example, lung cancer may result from a sufficient cause that includes smoking as a component cause. Smoking is not a sufficient cause by itself, however, because not all smokers develop lung cancer. Neither is smoking a necessary cause, because a small fraction of lung cancer victims have never smoked. Suppose Component Cause B is smoking and Component Cause C is asbestos. Sufficient Cause I includes both smoking (B) and asbestos (C). Sufficient Cause II includes smoking without asbestos, and Sufficient Cause III includes asbestos without smoking. But because lung cancer can develop in persons who have never been exposed to either smoking or asbestos, a proper model for lung cancer would have to show at least one more Sufficient Cause Pie that does not include either component B or component C.

Note that public health action does not depend on the identification of every component cause. Disease prevention can be accomplished by blocking any single component of a sufficient cause, at least through that pathway. For example, elimination of smoking (component B) would prevent lung cancer from sufficient causes I and II, although some lung cancer would still occur through sufficient cause III.