Routes of Transmission and the Introduction of Foreign Animal Diseases

overview 2
part 2

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Characteristics of Pathogens that Influence their Potential for Introduction

The innate characteristics of pathogenic organisms play a huge role in determining their modes of transmission. Understanding these characteristics is essential to preventing the introduction of a foreign animal disease and controlling or eradicating it once it has been introduced. Important characteristics that can influence the transmission of a pathogen include its persistence in the environment or in a host, the time required for it to become infective after it has been shed from a host, and other aspects of its life cycle. Some of the diseases cited below are not FADs, but serve as useful examples.

Persistence in the environment

Disease agents vary in their ability to survive outside a living host; some agents are quickly inactivated by sunlight, cold temperatures, pH changes, or other environmental factors while others can withstand harsh conditions for months or even years. The **persistence** of the organism in the environment determines how long we can expect to find the agent. Anthrax bacteria (*Bacillus anthracis*), for example, produce spores that persist in the environment for many years. Cases of anthrax can occur for decades in a contaminated pasture, in animals that have had no direct contact with an infected host. Agents that can persist in the environment for long periods of time, such as anthrax, can be particularly hard to eradicate.

Persistence in the host

Some pathogens enter the host temporarily; if they do not kill the host, they are eliminated by the immune response. Others can become permanent residents, persisting with or without symptoms for the lifetime of the animal. The maedi–visna virus, for example, usually infects a lamb or goat when it drinks contaminated milk or colostrum then becomes resident in that animal for life. Some animals infected with this virus develop dyspnea, neurologic signs, mastitis, or arthritis; however, many remain asymptomatic. These asymptomatic animals can, nevertheless, infect their offspring or other animals in close contact with them. Agents that persist in the host, such as the maedi–visna virus, can "hide" in asymptomatic hosts between clinical infections or epidemics. The asymptomatic carriers thus spread disease but are not readily detected as sources of the disease.

Persistence—the amount of time a disease agent can survive outside a living host

Some infections are maintained in a **reservoir** population between disease outbreaks. A reservoir is an animal or group of animals that continuously contains the disease agent and can spread it to other groups. In some cases, a single animal is persistently infected throughout its lifetime. In others, the agent is maintained in a population, where it is spread from animal to animal. Reservoir hosts serve as a habitat for the pathogen to survive and may or may not become ill from the infection. Migratory waterfowl, for example, sometimes act as reservoir hosts and can spread diseases to poultry flocks when the species come into close contact.

Amount of maturation required for infectivity

Some pathogenic agents are immediately infectious to an individual and do not require time for development either within the environment or within another host or vector. The cysts of *Giardia*, a protozoan that can cause diarrhea in numerous species, are immediately infectious to animals when shed. In contrast, some organisms require time to develop into an infectious stage. *Toxocara canis*, an ascarid of wild and domesticated dogs is a good example. The eggs of this parasite are unembryonated when shed in the feces and must develop for two to four weeks in the environment before they become infectious.

The life cycle of the pathogen

Many aspects of the pathogen's life cycle, already discussed, influence how easily it can be controlled and the points at which it can be destroyed. For example, some disease agents are found only in infected animals, passing directly from animal to animal. These agents can be controlled by destroying the agent within the host or preventing it from entering new hosts. The smallpox virus, which infects only humans, was eradicated by isolating infected humans and vaccinating their contacts. This approach, however, is only successful if the pathogen does not persist for long periods in the environment or in a host that must be kept alive, and does not enter vectors. Rinderpest fits these criteria and is a candidate for worldwide eradication. The host range of the pathogen is also important. Pathogens that infect a single host species are usually easier to control than agents that infect many different host species. Infected wildlife can be particularly difficult to identify and control; once a pathogen enters native wildlife, eradication may become impossible.

Parasitic diseases present additional complications. The control of a parasitic infection is influenced by whether the parasite's life cycle is direct or indirect. Parasites with a **direct life cycle** can complete their entire developmental cycle in a single host. Parasites with an **indirect life**

Reservoir—an animal or group of animals that continuously contains the disease agent and can spread it to other groups

cycle require an intermediate host, a host in which the agent develops but does not reach sexual maturity. Most parasitic trematodes (flukes) and cestodes (tapeworms) and some nematodes have indirect lifecycles. Many species may act as intermediate hosts. For example, snails are usually the first intermediate host of trematodes. Ticks may require one, two, or three hosts to complete their life cycle. The majority of hard tick species in North America have a three–host life cycle in which the larva, nymph, and adult feed on three different hosts.

Direct life cycle—indicates a parasite that can complete their entire development within a single host

Indirect life cycle—indicates a parasite that requires an intermediary host in which to develop but does not reach sexual maturity