

Edited by Jeroen Dewulf

# Biosecurity

in animal production  
and veterinary medicine

From  
principles  
to practice  
2nd Edition



# **BIOSECURITY IN ANIMAL PRODUCTION AND VETERINARY MEDICINE**

**From Principles to Practice**



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## **From Principles to Practice**

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Edited by

**Jeroen Dewulf**

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A catalogue record for this book is available from the British Library, London, UK.

ISBN-13: 9781800629844 (hardback)  
9781800629851 (ePDF)  
9781800629868 (ePub)

DOI: 10.1079/9781800629868.0000

Commissioning Editor: Alexandra Lainsbury  
Editorial Assistant: Emma McCann  
Production Editor: James Bishop

Typeset by Straive, Pondicherry, India  
Printed and bound in the UK by CPI Group (UK) Ltd, Croydon, CR0 4YY

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## Preface

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Just over a decade ago, while working with the US Department of Agriculture's Veterinary Services, I found myself sitting across the table from poultry producers during what was, at the time, the largest animal-health emergency the United States had ever experienced. Highly pathogenic avian influenza was moving faster and farther than expected, and our task was to understand how. We asked questions about barn layouts, ventilation systems, feed delivery, water sources, visitor flows, equipment sharing, and daily routines, the myriad small, practical details that together shape the health of animals and livelihoods.

That work was illuminating. We learned how viruses slip through barn doors, move between farms, and hitch rides on boots, vehicles, crates, and hands. We saw clearly that the way disease spreads between farms is not the same as the way it spreads between barns, and that no single biosecurity measure works everywhere. Effective prevention depended on barn type, species and age of birds, regional climate, production systems, and local geography. Yet amid all that diversity, one insight was strikingly consistent: good biosecurity is grounded in strong fundamentals, thoughtfully adapted to context. It requires discipline, awareness, and constant adjustment.

I wish I could say that we solved the challenge completely back then. We did not. Viruses continued to evolve. New threats emerged. Existing ones resurfaced in unexpected places. Today, producers, veterinarians, animal-health professionals, and policymakers must be prepared not for one crisis, but for many, often simultaneously. Animal pests and diseases continue to disrupt food systems, livelihoods, and trade, sometimes with cascading effects on human health and the environment. As production systems grow more complex and interconnected, the impacts of disease introduction become even more devastating.

That is not to say we have stood still. Quite the opposite. The past decade has brought advances in surveillance, diagnostics, data sharing, farm-level

technologies and innovations, improved genetics, and vaccines. We have learned, sometimes the hard way, that biosecurity is not a magical shield you deploy once and forget. It is a series of layered risk-reduction actions, none of them perfect, all of them essential. When aligned and sustained, these layers reduce vulnerability, safeguard animal health, and protect neighboring farms, markets, and trading partners.

When Dr Dewulf mentioned that he was working on a new edition of this book, I was immediately enthusiastic. Biosecurity today demands not only technical rigor, but also clarity, practicality, and humility. It requires guidance that speaks to farmers and veterinarians, industry leaders and regulators, students and researchers alike. We need biosecurity information grounded in science, informed by experience, and honest about trade-offs. This book does exactly that.

My perspective since 2014 has broadened considerably. In my current role at FAO, I see firsthand how weaknesses in one part of the system can expose risks elsewhere, and how strong biosecurity in one country contributes to resilience far beyond its borders. Disease prevention is no longer a purely national concern; it is a global public good.

FAO works with countries every day to strengthen biosecurity across production systems and value chains. This includes helping Members design risk-based integrated biosecurity approaches, improve farm-level practices, enhance border and market controls, strengthen veterinary services, and integrate animal health into broader One Health approaches. Just as importantly, FAO helps translate science into policy and policy into action, ensuring that biosecurity measures are feasible, inclusive, and sustainable.

The world in which this new edition is being released is more interconnected, and more fragile, than ever. Climate variability is altering disease ecology. Global demand for animal-source foods is increasing, even as production systems diversify. Trade volumes continue to grow, while misinformation spreads rapidly. At the same time, resources are constrained, and producers are under pressure to do more with less. In this environment, biosecurity is not simply about avoiding loss; it is about protecting opportunity, safeguarding livelihoods, and maintaining trust in food systems.

What excites me most about this book is its ability to bridge scales and perspectives. It recognizes that biosecurity decisions made at the level of a single farm connect directly to national preparedness and global health security. It treats biosecurity not as a checklist, but as a way of thinking that emphasizes risk awareness, shared responsibility, and continuous improvement. It acknowledges uncertainty, respects local knowledge, and reinforces the idea that progress is built through partnerships. And it also helps you understand when and how measuring biosecurity, or having a checklist, makes a difference.

As you turn these pages, I encourage you to read this book not only as a technical reference, but also as an invitation: to question assumptions, to adapt principles to your own context, and to see biosecurity as a living system rather than a static set of rules. Whether you are a producer working to protect your

farm, a veterinarian advising clients, a policymaker shaping national strategies, or a student preparing to enter the field, the insights here are both timely and enduring.

The challenges ahead are real, but so is our ability to address them. Strong biosecurity, rooted in science, and informed by experience, remains one of the most powerful tools we have to protect animal health, food security, and livelihoods worldwide. This new edition arrives at exactly the right moment, and it is my pleasure to welcome you to it.

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# 1

## Circles of Disease Transmission

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### **In this chapter, you will learn:**

- What the common steps in infection with various types of pathogens are.
- How pathogens spread from host to host.
- Which factors are important for the continued spread of pathogens in populations.
- How this knowledge can be utilized to 'break the chain' of disease transmission.

### **Abstract**

Common steps in the transmission of infectious agents from infected individuals to susceptible hosts include entry, development of disease (which may be subclinical), exit, and transmission to a new host. Airborne, droplet, and contact transmission comprise the three main transmission routes. Of those, airborne transmission is most difficult to control, but it is the least common. Some pathogens can also be disseminated via arthropod vectors or vertically from mother to foetus. On the population level, factors such as the density of susceptible hosts, the presence of reservoir hosts, and the pathogen's ability to survive in diverse environmental conditions also influence the efficiency of transmission. Knowledge of the common modes of transmission, along with host, pathogen, and environmental factors that affect spread, can be utilized for developing effective control strategies. Established transmission patterns may change, as pathogens adapt to evolving conditions. Human activities are contributing to these changes. Increasing population density has led to intensified agriculture and altered land use. Greater global connectivity through travel and trade, along with anthropogenic activities contributing to climate change, is likely to influence transmission dynamics by affecting the availability of susceptible hosts and vectors.

## 1. [Introduction](#)

Infectious agents that can cause disease in animals include viruses, bacteria, fungi, and parasites. Within each of these main groups, there are hundreds of potential pathogens with unique biological characteristics and life cycles. While the canonical Koch's postulates presumed a simple direct causative relationship between a pathogen and disease, even Koch himself predicted the inadequacy of such an assumption for all situations ([Fredericks and Relman, 1996](#)). Today, we have a much better appreciation of the multifactorial nature of many diseases and the complexity of events that determine the outcome of infection for each individual.

Understanding how pathogens are maintained within individual hosts and within populations enables us to interfere with this process. In a sense, the old saying 'know your enemy' is as applicable to microbes as it is to people. The better we understand the 'offenders' and the ways they use to survive and perpetuate themselves, the better we can effectively target the most relevant steps in their transmission circles.

This chapter provides a short overview of the steps necessary for the transmission of pathogenic microbes from one host to another. It is not meant to be a comprehensive review of the topic. Instead, it introduces some basic concepts, with an emphasis on common principles that can be exploited for infection control purposes.

## 2. [Common Steps in Transmission of Infectious Agents](#)

It is important to consider all potential pathogens that may be encountered in a given situation to design an effective infection control program ([Morley, 2002](#)). Many of those pathogens have unique biological properties and life cycles. While this needs to be considered, it is often practical to focus on commonalities, as opposed to differences. Most pathogens follow similar steps to establish infection in an individual host. These include entry, replication, spread within the host (either locally or systemically), which may or may not be accompanied by disease, and exit (inner circle in [Fig. 1.1](#)). On a population level, additional factors such as the density of susceptible hosts, presence of reservoir hosts, the ability of the pathogen to survive under varied environmental conditions, and common modes of transmission (outer circle in [Fig. 1.1](#)) also contribute to the efficiency of transmission. Altogether, the necessary infection steps and relevant host-, pathogen-, and environmental factors form the 'links' in the chain of transmission. Breaking one or more of such links through targeted infection control measures breaks the transmission circle.

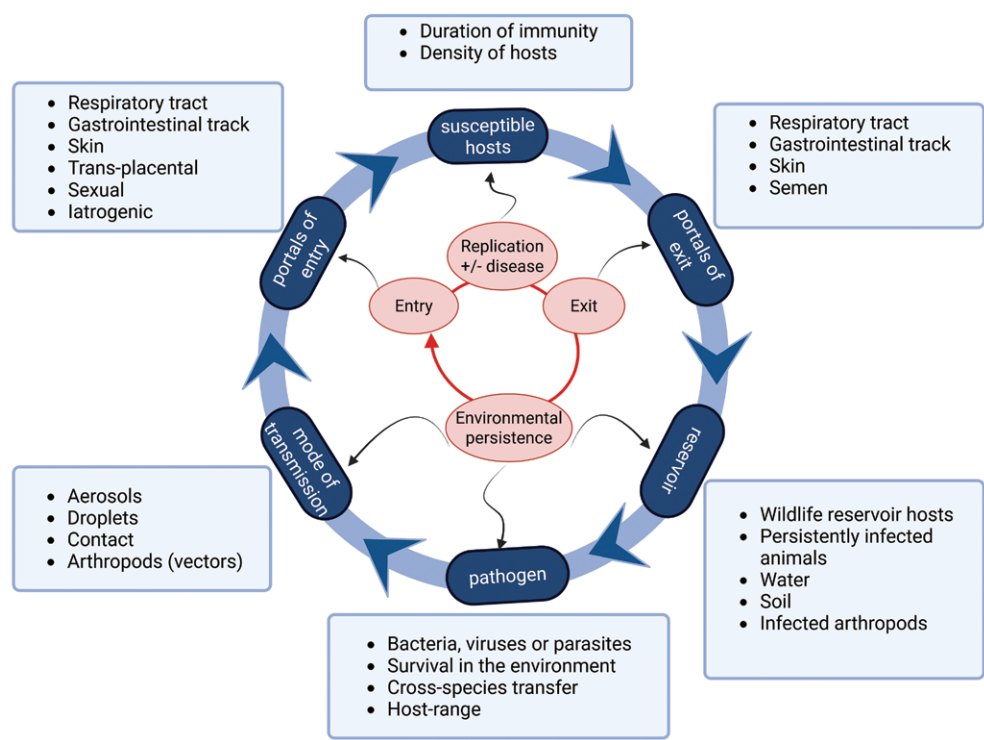


**Fig. 1.1.** Circles of disease transmission: common steps in a transmission cycle of infectious pathogens between individuals (inner circle) and factors that affect transmission of pathogens within populations (outer circle). Created in BioRender by author (2025).

**2.1. Entry**

Entry of the pathogen can occur via several routes (Table 1.1). The respiratory and gastrointestinal tracts are the most common entry routes for pathogenic micro-organisms. Some pathogens use predominantly one route of entry, while others use several. For example, bovine viral diarrhoea (BVD) virus can enter a new host via a respiratory route (droplet transmission), a venereal route (through natural service or contaminated equipment used for artificial insemination), or via transplacental infection of the foetus.

**2.2. Incubation period**

This defines the period between the start of infection (entry) and the development of disease. The length of the incubation period can range from hours (e.g., rotavirus, influenza viruses), days (e.g. foot-and-mouth disease (FMD) virus), to months (e.g., rabies virus) or even years (e.g., ovine progressive pneumonia lentivirus). The length of the incubation period is important for the