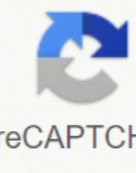
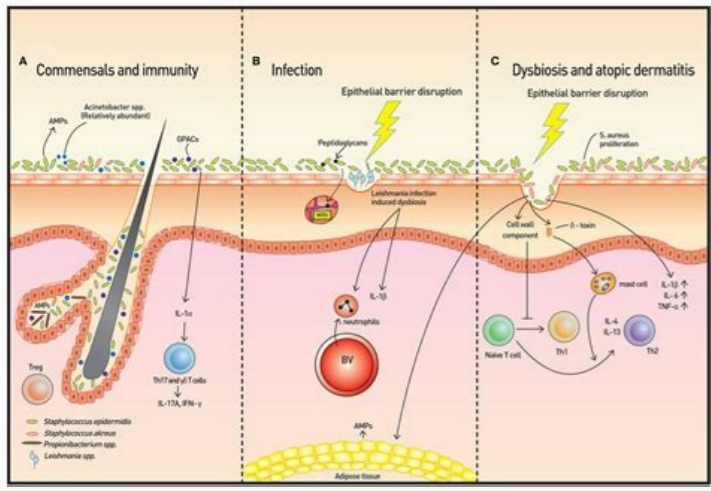


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Pathogen	Site	Effect	Signs	Prevention
Bacterial	Intestine	Diarrhoea	Stool	Antibiotics
Viral	Intestine	Diarrhoea	Stool	Antibiotics
Fungal	Intestine	Diarrhoea	Stool	Antibiotics
Parasitic	Intestine	Diarrhoea	Stool	Antibiotics
Protozoan	Intestine	Diarrhoea	Stool	Antibiotics



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REVIEW ARTICLE

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Plant-microbe interactions and the new biotechnological methods of plant disease control

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Abstract Plants constitute an excellent ecosystem for microorganisms. The environmental conditions offered differ considerably between the highly variable aerial plant part and the more stable root system. Microbes interact with plant tissues and cells with different degrees of dependence. The most interesting from the microbial ecology point of view, however, are specific interactions developed by plant-beneficial (either non-symbiotic or symbiotic) and pathogenic microorganisms. Plants, like humans and other animals, also become sick, but they have evolved a sophisticated defense response against microbes, based on a combination of constitutive and inducible responses which can be localized or spread throughout plant organs and tissues. The response is mediated by several messenger molecules that activate pathogen-responsive genes coding for enzymes or antimicrobial compounds, and produces less sophisticated and specific compounds than immunoglobulins in animals. However, the response specifically detects intracellularly a type of proteins of the pathogen based on a gene-for-gene interaction recognition system, triggering a biochemical attack and programmed cell death. Several implications for the management of plant diseases are derived from knowledge of the basis of the specificity of plant-bacteria interactions. New biotechnological products are currently being developed based on stimulation of the plant defense response, and on the use of plant-beneficial bacteria for biological control of plant diseases (biopesticides) and for plant growth promotion (biofertilizers).

Keywords Plant-microbe interaction · Plant disease · Hypersensitivity reaction

Introduction

Microorganisms have developed several strategies to adapt themselves to the plant environment, including beneficial or detrimental interactions. Beneficial interactions are caused by symbiotic or non-symbiotic bacteria and by a highly specialized type of fungi, the mycorrhizae. The pathogenic or detrimental interactions of microbes with plants involve viruses, bacteria and fungi, and lead to infectious diseases affecting only the plant kingdom. Losses in crop production due to plant disease average 13% in the world and severely limit production of food [2]. The 11,000 diseases that have been described in plants are caused by 120 genera of fungi, 30 types of viruses, and eight genera of bacteria (including two genera of molluscs) [2]. Thus, many plant diseases are caused by fungi, in contrast to the situation in animals, in which fungal diseases are less frequent. Since the normal state of plants is to be healthy, development of disease requires the coincidence of a susceptible host, a virulent pathogen, and a favorable environment. Also, suitable conditions for disease development are less frequent than one would expect because the pathogen population and the host plant change during their life cycle according to the stage of development (Fig. 1). These stages affect the virulence in the pathogen and the susceptibility in the host plant.

Disease is also strongly dependent on environmental conditions, especially in pathogens that have an epiphytic phase which is strongly dependent on water availability on the plant surface [2]. Temperature and surface wetness are environmental parameters that strongly affect microbial epiphytic life, as they determine growth rate, germination, taxis and other essential processes for colonisation of the plant surface. However, temperature and wetness levels often exhibit strong changes, even

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Endotoxins Vs Exotoxins

	Exotoxin	Endotoxin
Species	Some species of both Gram-positive and Gram-negative bacteria	Most Gram-negative bacteria and <i>Listeria</i>
Protein Location	Proteins secreted from cell	Part of cell (lipopolysaccharide) that fragments off
Gene Location	Genes for exotoxin are in plasmid or bacteriophage	Genes for endotoxin are on bacterial chromosome
Toxicity	High toxicity	Low toxicity
Antigenicity	Highly antigenic (host forms antibodies called antitoxins)	Poorly antigenic
Vaccine	Vaccine available (formed from toxoids)	No vaccine available
Heat Stability	Heat labile	Heat stable
Example	Think cholera, tetanus, botulism	Think meningococemia, sepsis



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