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## **Microorganisms**

### Abstract

The discovery of microorganisms revolutionized science and medicine, opening up a world previously invisible to the human eye. This breakthrough began in the late 17th century with the pioneering work of Antonie van Leeuwenhoek. Using a single-lens microscope he had developed, Leeuwenhoek observed and documented tiny living organisms, called "animalcules," in water samples, dental plaque, and other substances. His meticulous observations and detailed drawings laid the foundation for microbiology. Following Leeuwenhoek's discoveries, further advancements were made in the understanding and identification of microorganisms. In the 19th century, Louis Pasteur and Robert Koch made significant contributions that established microbiology as a scientific discipline. Pasteur's experiments disproved the theory of spontaneous generation and demonstrated that microorganisms were responsible for fermentation and disease. His development of pasteurization, a process to kill harmful bacteria in food and drinks, profoundly impacted public health. Robert Koch, known as the father of bacteriology, developed methods for isolating and growing bacteria in pure cultures, which allowed for the identification of specific pathogens responsible for diseases such as tuberculosis, cholera (Vibrio cholerae), and anthrax. Koch's postulates, a criterion for proving the causative relationship between a microbe and a disease, remain fundamental in microbiological research today.

**Keywords**: Spontaneous generation, Pasteur, Leeuwenhoek, Specific pathogens, *Vibrio cholerae*.

***Mikroorganizmalar***

**Özet**

Mikroorganizmaların keşfi bilim ve tıpta devrim yarattı ve daha önce insan gözünün göremediği bir dünyanın kapılarını açtı. Bu atılım 17. yüzyılın sonlarında Antonie van Leeuwenhoek'in öncü çalışmasıyla başladı. Leeuwenhoek, geliştirdiği tek lensli mikroskobu kullanarak su örneklerinde, diş plaklarında ve diğer maddelerde "hayvancıklar" adı verilen küçük canlı organizmaları gözlemledi ve belgeledi. Titiz gözlemleri ve ayrıntılı çizimleri mikrobiyolojinin temelini attı. Leeuwenhoek'un keşiflerinin ardından mikroorganizmaların anlaşılması ve tanımlanmasında daha fazla ilerleme kaydedildi. 19. yüzyılda Louis Pasteur ve Robert Koch, mikrobiyolojinin bilimsel bir disiplin olarak yerleşmesine önemli katkılarda bulundular. Pasteur'ün deneyleri kendiliğinden oluşma teorisini çürüttü ve fermantasyon ve hastalıktan mikroorganizmaların sorumlu olduğunu gösterdi. Yiyecek ve içeceklerdeki zararlı bakterileri öldürmeye yönelik bir süreç olan pastörizasyonu geliştirmesi, halk sağlığını derinden etkiledi. Bakteriyolojinin babası olarak bilinen Robert Koch, tüberküloz, kolera (*Vibrio cholerae*) ve şarbon gibi hastalıklardan sorumlu spesifik patojenlerin tanımlanmasına olanak tanıyan, saf kültürlerde bakterileri izole etmek ve büyütmek için yöntemler geliştirdi. Bir mikrop ile bir hastalık arasındaki nedensel ilişkiyi kanıtlamaya yönelik bir kriter olan Koch'un varsayımları, bugün mikrobiyolojik araştırmalarda temel olmaya devam etmektedir.

**Anahtar kelimeler:** Sponten, Pasteur, Leeuwenhoek, Spesifik patojenler, *Vibrio cholerae*.

### 1. INTRODUCTION

Almost all foods (except for a few, such as those subjected to high-temperature processing) contain one or more groups of microorganisms. Some of these play desirable roles in foods (e.g., the production of naturally fermented foods), while others cause spoilage or foodborne illnesses. To investigate and control the role of microorganisms in foods, it is necessary to isolate them in pure cultures and determine their morphology, physiology, biochemical and genetic characteristics. Some simple methods used in these types of studies today have been developed over the past 300 years.

### 2. HISTORICAL DEVELOPMENT OF FOOD MICROBIOLOGY

#### 2.1 Discovery of Microorganisms

The discovery of microorganisms paralleled the invention and development of the microscope. Around 1658, Athanasius Kircher reported observing tiny worms in spoiled milk and meat using a microscope, although the magnification was insufficient to see bacteria. In 1664, Robert Hooke described the structure of molds. However, the first person to observe different types of microorganisms, especially bacteria, was likely Antony van Leeuwenhoek, using a microscope with a magnification not exceeding 300 times. Leeuwenhoek examined bacteria in saliva, rainwater, vinegar, and other materials, classifying the organisms he saw into three morphological groups: spherical (cocci), cylindrical (bacilli), and spiral (spirilla), and noted their motility. His observations, made between 1676 and 1683, were the only ones accepted in scientific work for over a century due to the lack of better microscopes at that time. The industrial revolution in the 19th century led to the development of more advanced microscopes, making it possible to examine and describe many more organisms. In 1830, Ehrenberg proposed the term "bacteria" and classified them into four genera with at least 16 species. In 1875, Ferdinand Cohn developed the first preliminary classification system for bacteria and discovered spore-producing bacteria. The discovery of the electron microscope in the mid-20th century (1940) allowed even viruses, which closely resemble bacteria, to be visualized.

#### 2.2. Origin of Microorganisms

Following Leeuwenhoek's discovery, there was not much focus on observation activities, but some scientific views suggested that curious observers found "animalcules" in various objects. During this period, society was in the early stages of the Renaissance and the experimental philosophy of science. The "spontaneous generation" theory (the idea that living organisms could arise from nonliving matter) was supported by many educated and elite individuals. The phenomenon of maggot generation, observed in dead bodies and decaying matter since the time of the Greeks, was considered spontaneous generation. However, around 1665, a study to disprove this theory showed that maggots, described as unknown creatures, appeared if decaying meat and fish were allowed to be exposed to insects. Supporters of the spontaneous generation theory argued that maggots could not reanimate themselves (biogenesis), but they were found during abiogenesis (spontaneous generation) in different generations. In 1749, Turbevill Needham demonstrated the presence of creatures called maggots in boiled meat or meat broth stored in a closed container. Lazzaro Spallanzani, in 1765, sealed the container of boiled meat broth to prevent contamination by microscopic organisms, disproving Needham's theory. Antoine Lavoisier and his colleagues later determined that some organisms required oxygen. Spallanzani's theory suggested that spontaneously generated microbial organisms did not need oxygen. However, it was shown that spontaneously generated organisms did need oxygen. Schulze, in 1830, passed air through acid; Theodore Schwann, in 1838, passed air through a hot tube; and Schröder, in 1854, used air passed through cotton filters to show that bacteria did not develop in boiled meat broth. Finally, Louis Pasteur, in 1861, demonstrated that bacteria in dust contaminated boiled meat broth, leading to the growth of organisms. These experiments conclusively disproved the spontaneous generation theory, with John Tyndall in 1870 showing that no microorganisms developed in boiled meat broth stored in a dust-free container.

#### 2.3. Functions of Microorganisms

The role of invisible organisms in many diseases was first suggested by Roger Bacon in the 13th century. In the 16th century, Girolamo Fracastoro of Verona proposed that many animal diseases were spread by small creatures from person to person. Kircher also mentioned this idea in 1658. In 1762, Vienna's von Plenciz suggested that invisible organisms were responsible for various diseases. Theodore Schwann (1837) and Hermann Helmholtz (1843) proposed that putrefaction and fermentation were caused by airborne organisms. Finally, Pasteur, in 1875, demonstrated that grapes' wine production and the souring of wine were caused by microorganisms. He also showed that the spoilage of meat and milk was related to microorganisms. Pasteur later suggested that microorganisms played a role in many human and animal diseases and developed vaccines for many of these diseases. Between 1880 and 1890, Robert Koch in Germany isolated bacteria responsible for diseases such as anthrax, cholera, and tuberculosis in pure cultures. He also developed Koch's postulates, which established a relationship between specific bacteria and specific diseases. Koch and his colleagues developed the agar plate method for bacterial isolation and enumeration, petri dishes, and staining techniques for better bacterial observation. Special methods were used to achieve advances in microbiology related to soil fertility, plant diseases, fermentation, food spoilage, foodborne illnesses, and other areas. Over time, the importance of microorganisms in human and animal diseases was realized, leading to the development of microbiology as a distinct discipline. Later, advances were made in different fields such as medical microbiology, soil microbiology, plant pathology, and food microbiology.

#### 2.4 Early Developments in Food Microbiology

It is logical to assume that our ancestors, engaged in hunting and agriculture, were aware of foodborne illnesses and food spoilage. In the past, food was made safe using ice or fire. Around 8000 BCE, the domestication of plants and animals marked the beginning of settled agriculture. The preservation of food became crucial alongside the production of normal food. Between 8000 and 1000 BCE, various food preservation methods, such as drying, cooking, baking, smoking, salting, sweetening (using honey), low-temperature storage (in ice), anaerobic storage (underground), fermentation (fruits, vegetables, grains, and milk), pickling, and spicing, were likely used to reduce food spoilage. Leeuwenhoek's discovery of the omnipresence of microorganisms in the 1670s suggested their role in food spoilage, fermentation, and foodborne illnesses. Before the 19th century, in the 1870s, many scientists began studying food microorganisms following Pasteur's findings. This laid the foundation for microbiological studies in the 20th century. Some significant historical events related to food preservation, spoilage, and foodborne illnesses in the 19th century are listed below.

#### 2.5 Current Status of Food Microbiology

In the early 20th century, work continued to understand the importance and interaction of microorganisms, particularly pathogenic bacteria, in foods. Special methods were developed for the isolation and identification of microorganisms. The importance of sanitation in food storage to reduce contamination was emphasized. Specific methods were studied to kill spoilage and pathogenic bacteria and prevent their growth. There was also significant interest in isolating beneficial bacterial sources for food fermentations, especially dairy fermentations. After 1950, food microbiology entered a new era. Information on the biological characteristics, physiology, biochemistry, and genetics of various types of microbial interactions with foods and their environments helped open new areas in food microbiology. Recent years have seen a focus on food fermentation and probiotics, food spoilage, foodborne diseases, and other topics.

##### **2.5.1 Food Fermentation and Probiotics**

Fermentation is an important biochemical process that produces ATP through glycolysis under anaerobic conditions, i.e., in the absence of oxidative phosphorylation. Studies related to fermentation and probiotics include:

* Developing desired metabolic activity species through genetic transfer among species.
* Developing lactic acid bacteria resistant to bacteriophages.
* Developing methods for using lactic acid bacteria to carry immune proteins.
* Sequencing the genomes of significant lactic acid bacteria and identifying key genes involved in lactic acid fermentation, producing antibiotics, carrying vaccines, and other activities.

##### **2.5.2 Food Spoilage**

Efforts are being made to detect the production of toxic materials, enzymes, and volatile compounds by microorganisms associated with food spoilage. Many bacteria (e.g., Alcaligenes spp., Bacillus spp., and Micrococcus spp.), yeasts (e.g., Saccharomyces spp.), and molds (e.g., Aspergillus spp., Cladosporium spp.) are involved in food spoilage. The importance of intrinsic (e.g., food pH) and extrinsic (e.g., storage temperature) factors affecting the types and extent of microorganisms involved in food spoilage is being investigated. Various chemical and physical methods are used to control spoilage microorganisms. Research is conducted to develop biological methods to control these organisms, such as bacteriocins and protective cultures. Efforts are made to detect spoilage microorganisms in food by various rapid methods (e.g., bioluminescence).

##### **2.5.3 Foodborne Diseases**

Foodborne diseases have been recognized since ancient times. For example, in Leviticus (an ancient religious book), the association between disease and consumption of spoiled fish and meat was mentioned. Historically, foodborne diseases such as typhoid fever, dysentery, staphylococcal intoxications, tuberculosis, brucellosis, trichinosis, and botulism were known. For the past 25 years, diseases such as salmonellosis, listeriosis, hemorrhagic colitis caused by E. coli O157, and various viral diseases have received much attention. Efforts are being made to improve and develop various methods to detect foodborne pathogens rapidly, including ELISA (enzyme-linked immunosorbent assay), PCR (polymerase chain reaction), and others. Identifying the mechanisms by which pathogens cause disease is receiving significant attention. Investigations are conducted to better understand the physiological status and genetic mechanisms of foodborne pathogens in foods and their environments.

### 3. CONCLUSION

Recent developments in the biology of microorganisms in foods have shed light on the roles of microorganisms in various fields of food microbiology. These developments have significant implications for food preservation, food safety, and the use of microorganisms for beneficial purposes such as fermentation and probiotics. Understanding the interactions of microorganisms with foods and their environments helps address food spoilage, foodborne diseases, and food fermentation challenges. Continuous research and advancements in food microbiology will likely lead to further innovations and improvements in food safety and quality.

**Conflict of Interest**

The authors declare that they have no conflict of interest.

**KAYNAKLAR**

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