# *Host-Microorganism Interactions*

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diagnostic microbiology

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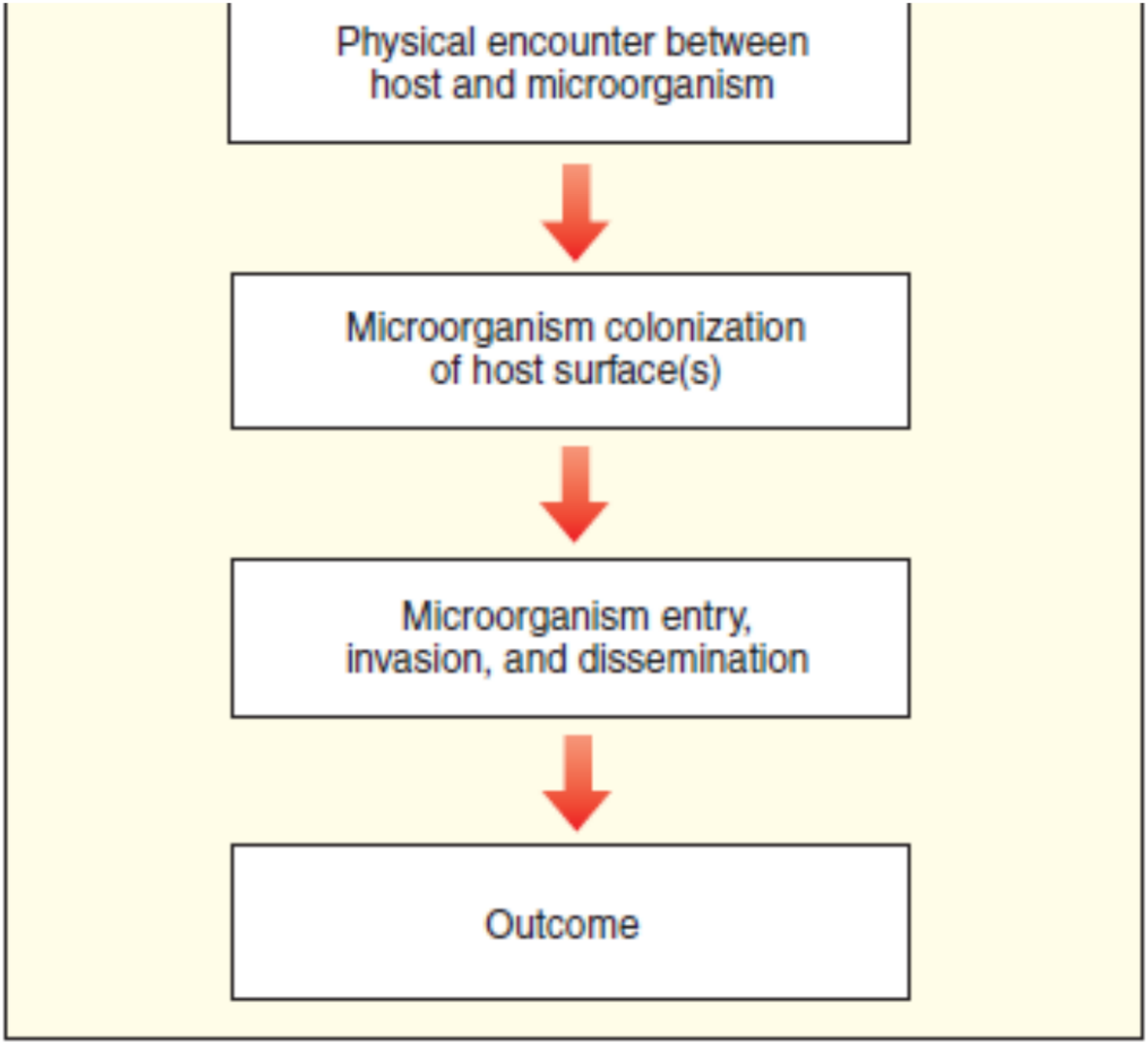



**Figure 3-1** General stages of microbial-host interaction.

# THE HUMAN HOST’S PERSPECTIVE

The role that human activities play in the encounter process cannot be overstated because most of the crises associated with infectious disease could be avoided or greatly reduced if human behavior and living conditions could be changed.

# Microbial Reservoirs and Transmission:

The environment or place of origin, of the infecting agent is referred to as the reservoir

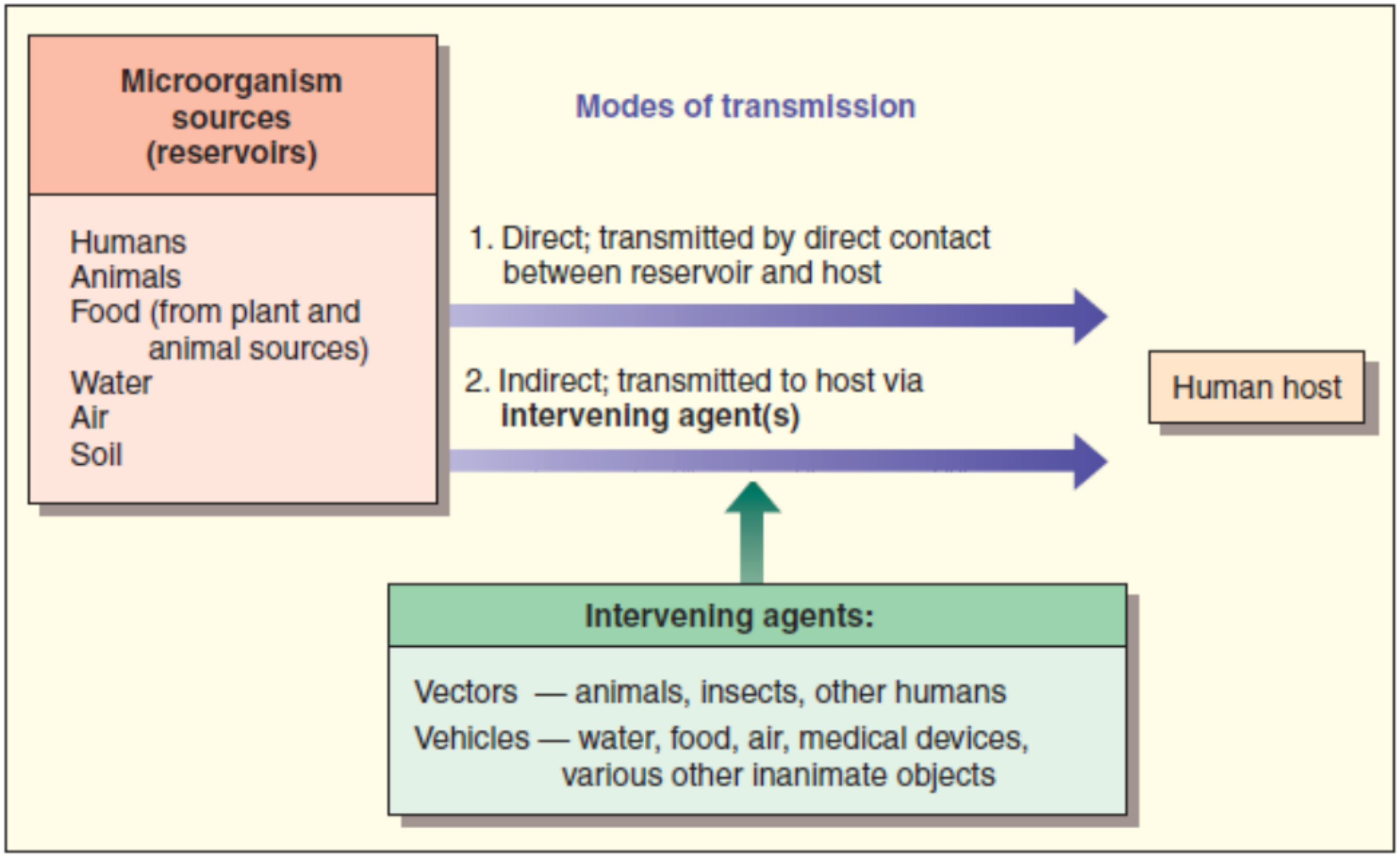



**Figure 3-2** Summary of microbia reservoirs and modes of transmissi to humans.

# Humans as Microbial Reservoirs

**Direct transfer:**
**-newborns first encounter microbial agents**
**-hepatitis by blood transfusions**
**-gonorrhea, syphilis by sexual contact**
**-tuberculosis by coughing; and the common cold through sneezing**

**Indirect transfer:**
**-a vehicle of transmission such as water (e.g., cholera)**
**-medical devices helps disseminate infections in hospitals.**

**Hospital-acquired infections are referred to as nosocomial infections.**

# Animals as Microbial Reservoirs

## directly transmitted:

-through an animal bite (e.g., rabies)

## Indirect:

-through the bite of insect vectors that feed on both animals and humans (e.g., Lyme disease and Rocky Mountain spotted fever)
-by water and food supplies (beaver)
-animals used for human food carry numerous bacteria (e.g., Salmonella and Campylobacter)

- information regarding a patient's exposure to animals is often a key component to diagnosing these infections

tick

beaver

Petechial rash caused by Rocky Mountain spotted fever on the arm

**Some microorganisms primarily infect animal populations and on occasion accidentally encounter and infect humans.**

**Such infectious diseases are classified as zoonotic infection**

## Insects as Vectors:

**The most common role of insects (arthropods) in the transmission of infectious diseases is as vectors rather than as reservoirs.**

**transmit viral, parasitic, and bacterial diseases from animals to humans.**

**others transmit microorganisms between human hosts without an animal reservoir being involved.**
**-Malaria by mosquitoes**

# The Environment as a Microbial Reservoir

**The soil and natural environmental debris are reservoirs for countless types of microorganisms.**

**Many of the fungal agents are acquired by inhalation of soil and dust particles containing the microorganisms (e.g., San Joaquin Valley fever).**

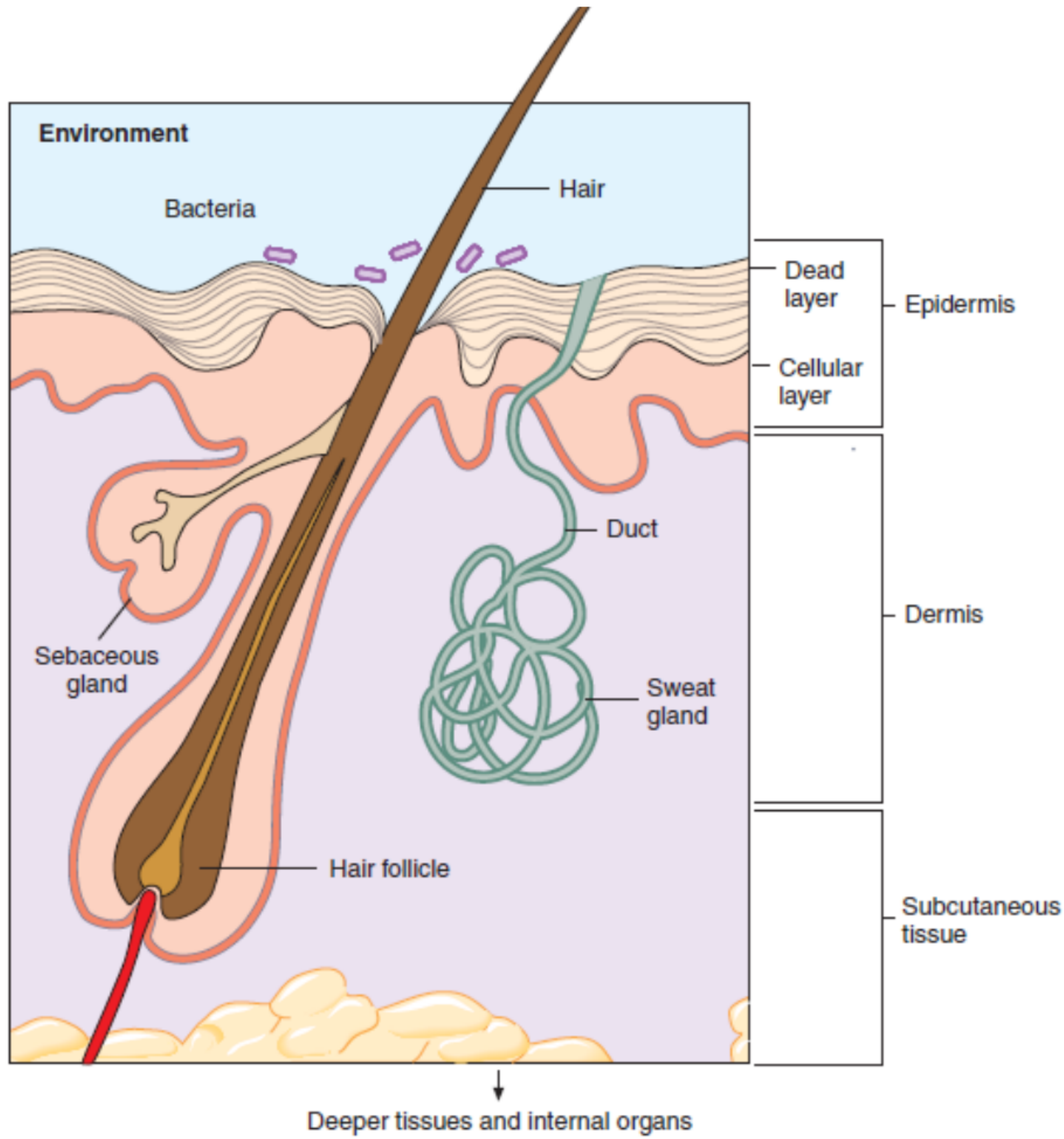
**bacterial agents (e.g., tetanus) may result when microbial agents in the environment are introduced into the human body as a result of a penetrating wound.**

## MICROORGANISM COLONIZATION OF HOST SURFACES:

Once a microbe and the human host are brought into contact, the outcome of the encounter depends on what happens during each step of interaction, beginning with colonization. The human host's role in microbial colonization, defined as the persistent survival of microorganisms on a surface of the human body, is dictated by the defenses that protect vital internal tissues and organs against microbial invasion

**The first defenses are the external and internal body surfaces** that are in relatively direct contact :

- **Skin (including conjunctival epithelium covering the eye)**
- **Mucous membranes that line the mouth or oral cavity, the respiratory tract, the gastrointestinal tract, and the genitourinary tract**


Environment
Hair
Bacteria
Dead layer
Cellular layer
Epidermis
Duct
Dermis
Sebaceous gland
Sweat gland
Hair follicle
Subcutaneous tissue
Deeper tissues and internal organs

## BOX 3-1 Protective Characteristics of the Skin and Skin Structures

| SKIN STRUCTURE | PROTECTIVE ACTIVITY |
| --- | --- |
| Outer (dermal) layers | Physical barrier to microbial penetration<br>Sloughing of outer layers removes attached bacteria<br>Provide dry, acidic, and cool conditions that limit bacterial growth |
| Hair follicles, sweat glands, sebaceous glands | Production of acids, alcohols, and toxic lipids that limit bacterial growth |
| Conjunctival epithelium covering the eyes | Flushing action of tears removes microorganisms<br>Tears contain lysozyme that destroys bacterial cell wall |
| Skin-associated lymphoid tissue | Mediate specific and nonspecific protection mechanisms against microorganisms that penetrate outer tissue layers |

## Mucous Membranes:

line the respiratory tract, gastrointestinal tract, and genitourinary tract

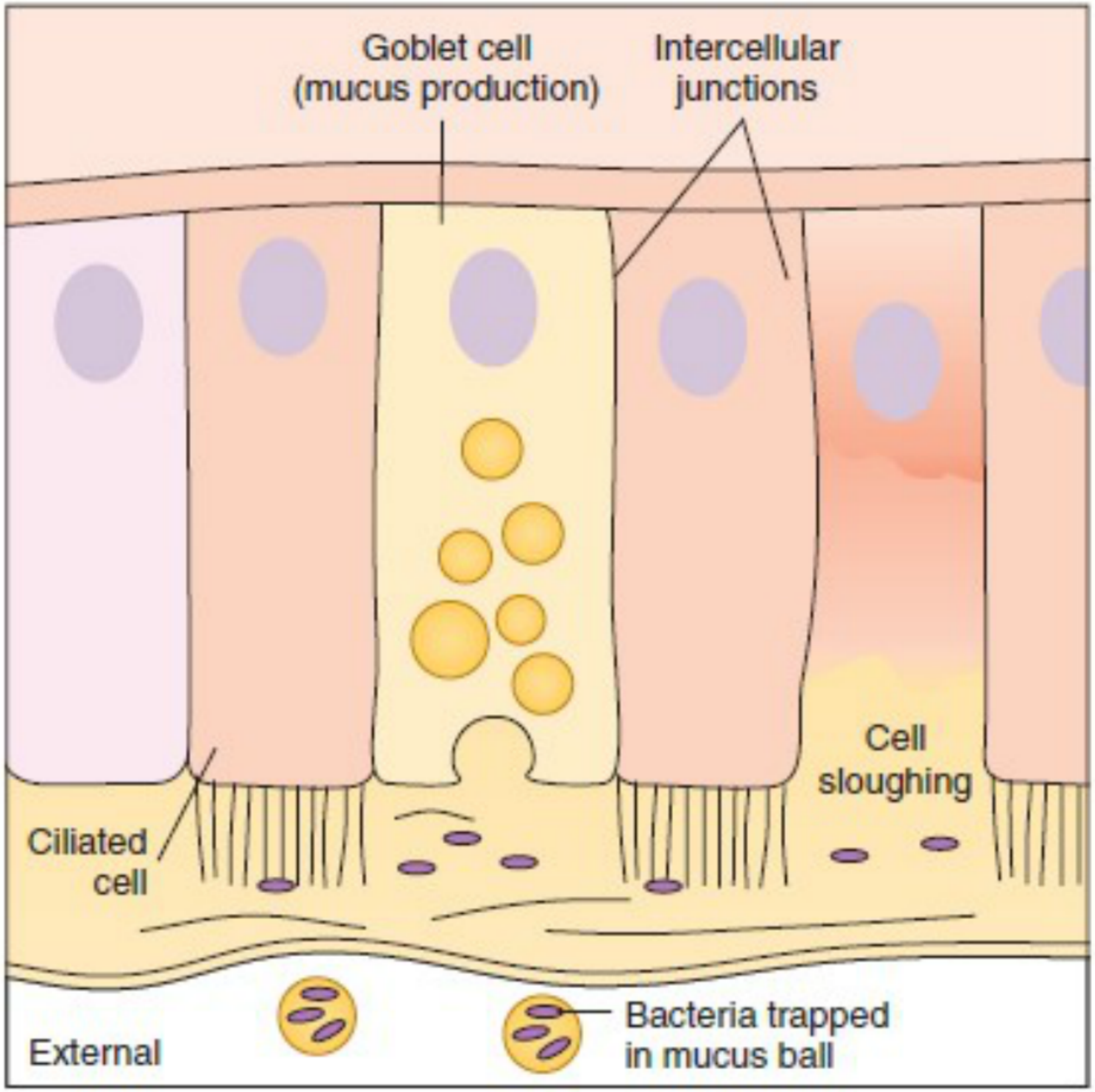



**Figure 3-4** General features of mucous membranes highlighting protective features such as ciliated cells, mucus production, tight intercellular junctions, and cell sloughing.

## BOX 3-2 Protective Characteristics of Mucous Membranes

| MUCOUS MEMBRANE STRUCTURES | PROTECTIVE ACTIVITY |
|---|---|
| Mucosal cells | Rapid sloughing for bacterial removal<br>Tight intercellular junctions prevent bacterial penetration |
| Goblet cells | Mucus production:<br>Protective lubrication of cells<br>Bacterial trapping<br>Contains specific antibodies with specific activity against bacteria<br>Provision of antibacterial substances to mucosal surface:<br>Lysozyme: degrades bacterial cell wall<br>Lactoferrin: competes for bacterial iron supply<br>Lactoperoxidase: production of substances toxic to bacteria |
| Mucosa-associated lymphoid tissue | Mediates specific responses against bacteria that penetrate outer layer |

## MICROORGANISM ENTRY, INVASION, AND DISSEMINATION:

In most instances, to establish infection, microorganisms must penetrate or circumvent the host's physical barriers (i.e., skin or mucosal surfaces)

When these barriers are broken, numerous other host defensive strategies are activated.

# Disruption of Surface Barriers

**It is Any situation that disrupts the physical barrier of the skin and mucosa**

**1- alters the environmental conditions (e.g., loss of stomach acidity or dryness of skin)**

**2- changes the functioning of surface cells**

**3- alters the normal flora population can facilitate the penetration of microorganisms past the barriers and into deeper host tissues.**

## BOX 3-4 Factors Contributing to Disruption of Skin and Mucosal Surface

**TRAUMA:** Penetrating wounds
Abrasions
Burns (chemical and fire)
Surgical wounds
Needlesticks
**INHALATION:** Smoking
Noxious or toxic gases
**IMPLANTATION OF MEDICAL DEVICES**
**OTHER DISEASES:** Malignancies
Diabetes
Previous or simultaneous infections
Alcoholism
**CHILDBIRTH**
**OVERUSE OF ANTIBIOTICS**

# Responses to Microbial Invasion of Deeper Tissues:

Some of these responses are nonspecific because they occur regardless of the type of invading organism, whereas other responses are more specific and involve the host's immune system.

Without them, microorganisms would multiply and invade vital tissues and organs unchecked, resulting in severe damage to the host

## Nonspecific Responses:

**Some nonspecific responses are biochemical; others are cellular**. Biochemical factors remove essential nutrients, such as iron, from tissues so that they cannot be used by invading microorganisms. Cellular responses are central to tissue and organ defenses, and the cells involved are known **as phagocytes**.

**Phagocytes** are cells that ingest and destroy bacteria and other foreign particles.

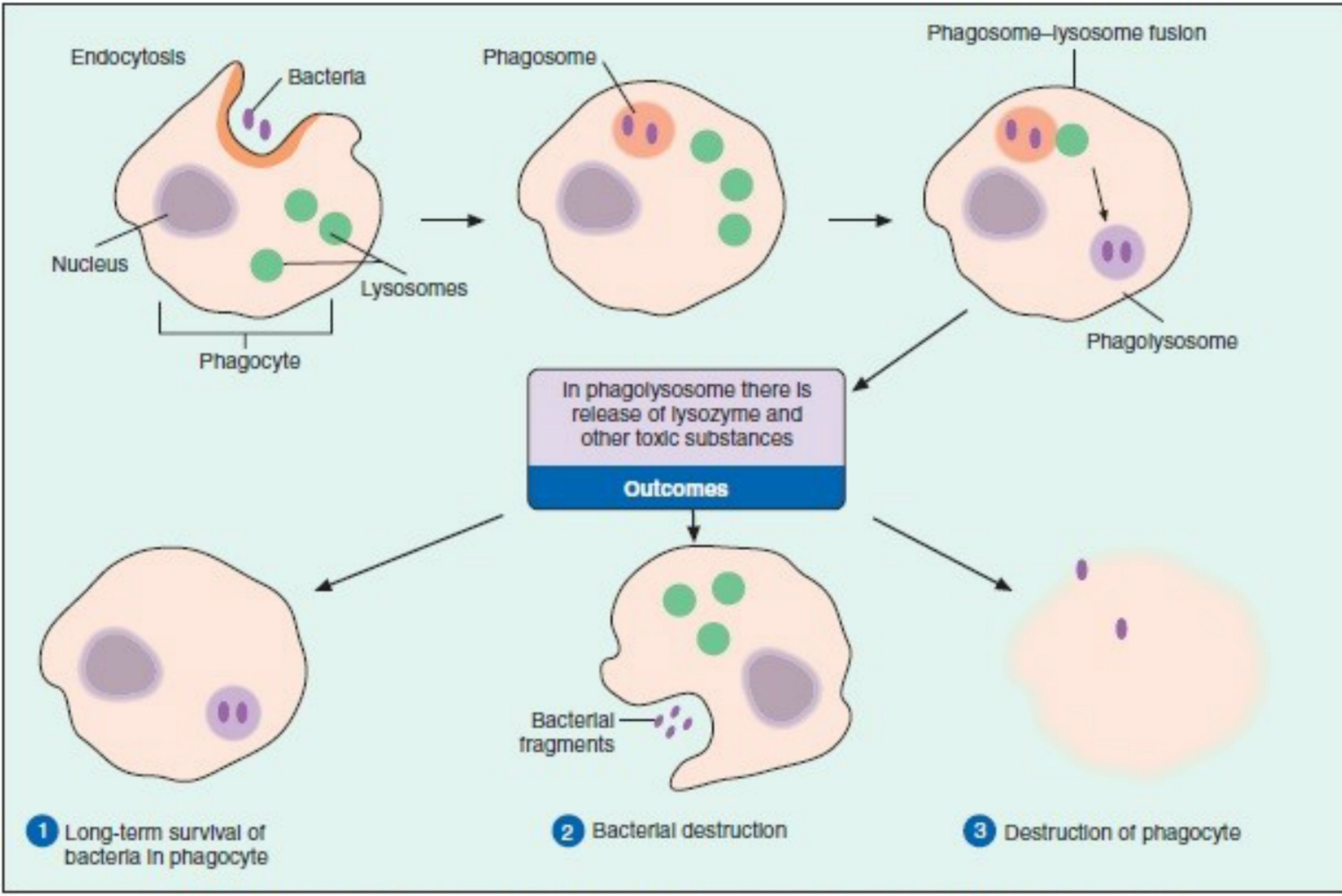



**Figure 3-6** Overview of phagocyte activity and possible outcomes of phagocyte-bacterial interactions.

**Inflammation(nonspecific):**

Because microbes may survive initial encounters with phagocytes, the inflammatory response plays an extremely important role as a reinforcement mechanism against microbial survival and proliferation in tissues and organs. Inflammation has both cellular and biochemical components that interact in various complex ways.

# Inflammation contains of:

1- The complement system is composed of a coordinated group of proteins that are activated by the immune system or by the mere presence of invading microorganisms

2- phagocytes

3- coagulation system, which works to increase blood flow to the area of infection and can also effectively wall off the infection through the production of barrier substances.

4- cytokines, substances secreted by cells that have substantial effects on the anti infective activities of other cells

The manifestations of inflammation are evident and familiar to most of us and include the following:

- Swelling—caused by increased flow of fluid and cells to the affected body site
- Redness—results from vasodilation of blood vessels at the infection site
- Heat—results from increased temperature of affected tissue
- Pain—due to tissue damage and pressure from increased flow of fluid and cells

On a microscopic level, **the presence of phagocytes at the infection site is an important observation in diagnostic microbiology**. Microorganisms seen associated with these host cells are frequently identified as the cause of a particular infection.

## BOX 3-5 Components of Inflammation

| COMPONENT | FUNCTIONS |
|---|---|
| Phagocytes (PMNs and macrophages) | Ingest and destroy microorganisms |
| Complement system (coordinated group of serum proteins) | Attracts phagocytes to site of infection<br>Helps phagocytes recognize and bind to bacteria<br>Directly kills gram-negative bacteria |
| Coagulation system (wide variety of proteins and other biologically active compounds) | Attracts phagocytes to site of infection<br>Increases blood and fluid flow to site of infection<br>Walls off site of infection to physically inhibit spread of microorganisms |
| Cytokines (proteins secreted by macrophages and other cells) | Multiple effects that enhance the activities of many different cells essential to nonspecific and specific defensive responses |

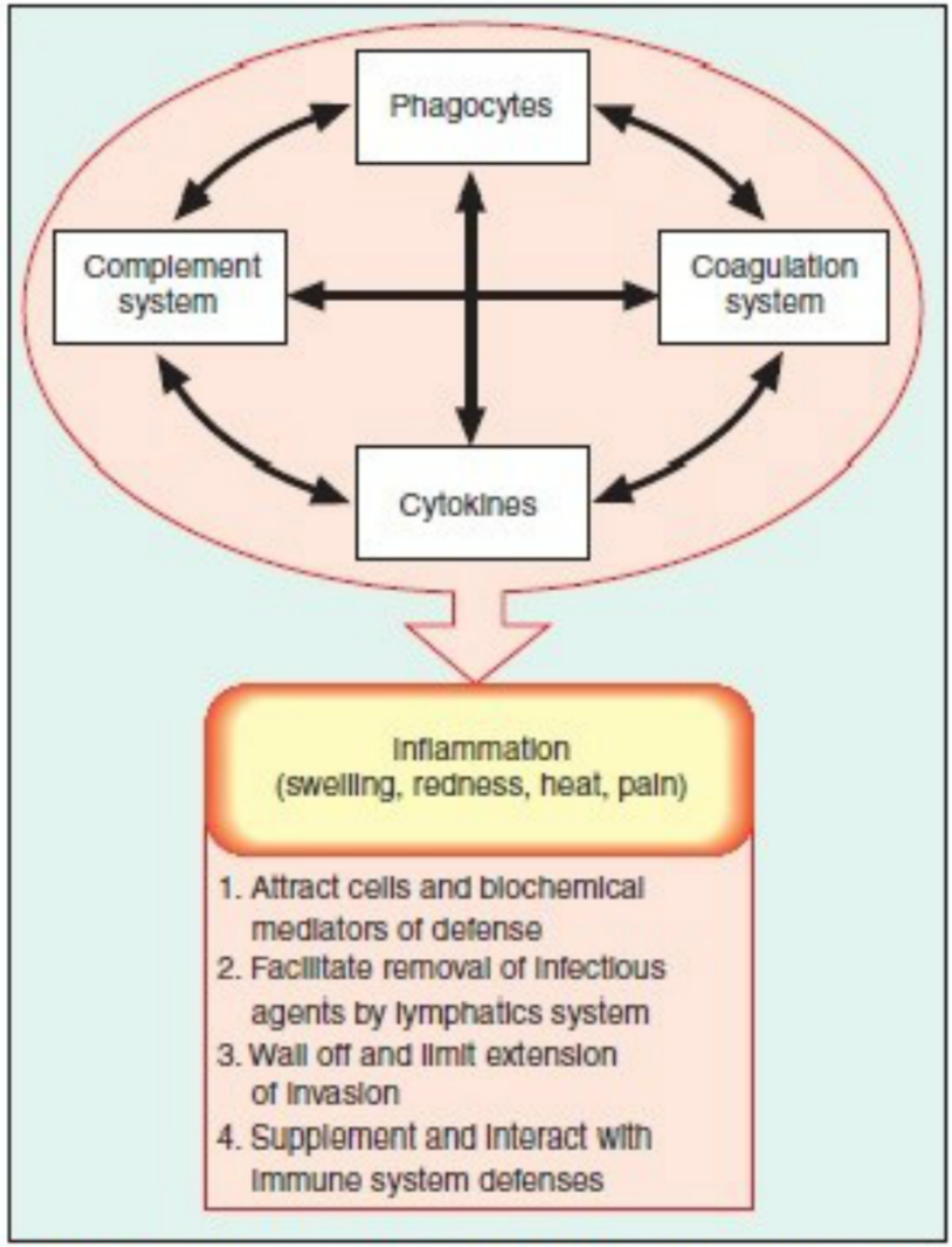



**Figure 3-7** Overview of the components, signs, and functions of inflammation.