Host Defense Mechanisms (non-specific(

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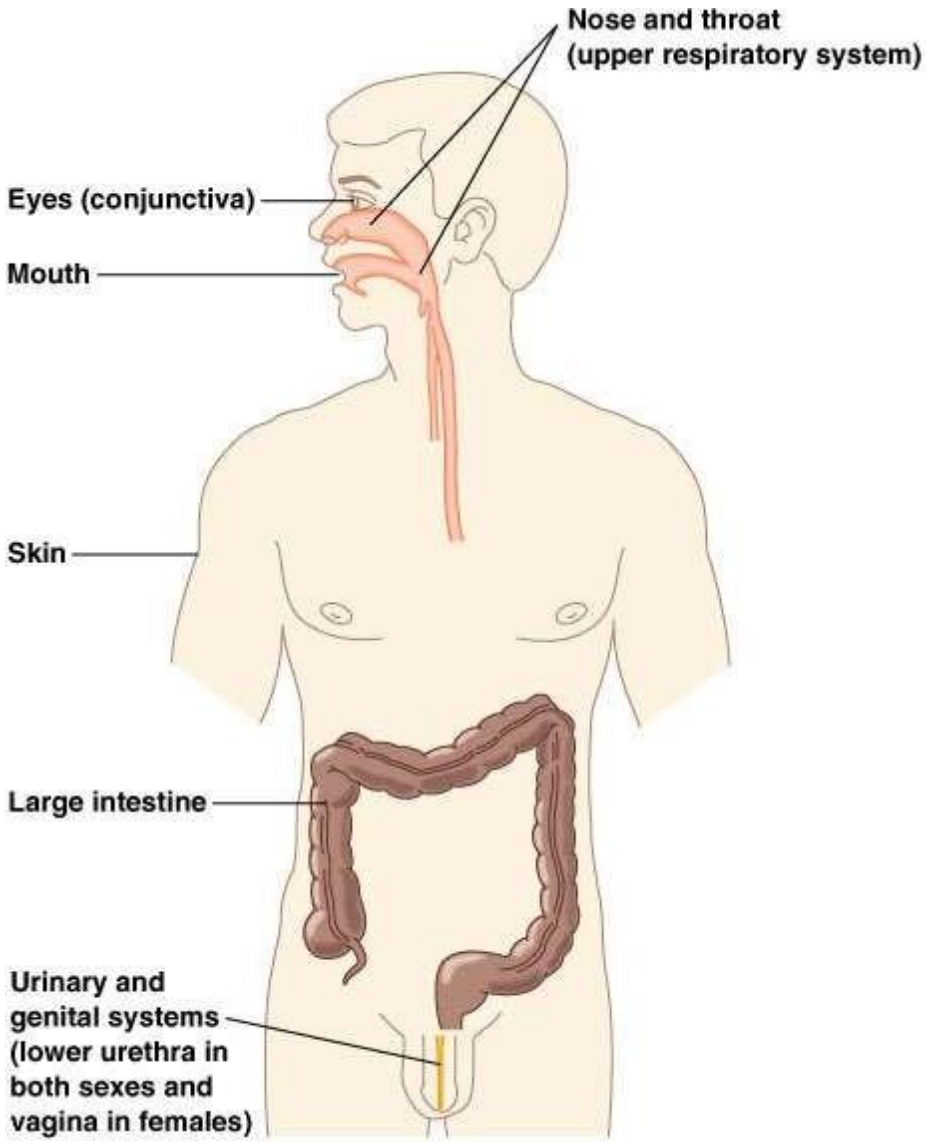
Host Defenses

- Resistance
  - Ability to ward off disease
  - Varies among organisms and individuals within the same species
- Immunity - mechanisms used by the body as protection against microbes and other foreign agents; self vs. non-self
- Nonspecific immunity (innate, natural)
  - Defenses against any pathogen
- Specific immunity
  - Resistance to a specific pathogen

Host Defenses

Nonspecific Resistance		Specific Resistance (Responses of the Immune System,
First line of defense	**Second line of defense**	**Third line of defense**
• Intact skin • Mucous membranes and their secretions • Normal microbiota	• Phagocytic white blood cells • Inflammation • Fever • Antimicrobial substances	• Specialized lymphocytes: B cells and T cells • Antibodies

First line of defense – physical & chemical barriers



First line of defense – physical & chemical barriers

- Intact, unbroken skin (Broken skin = port of entry(
  - Almost all bacteria are incapable to penetrate a few helminths (hookworm & schistosoma) may
  - skin predominantly inhabited by *Staphylococcus epidermidis*
  - How؟
    - Dryness
    - temperature
    - Low pH (acidic) of skin؛
    - bacteriocidal secretion by the sebaceous glands
    - Desquamation – sloughing of epithelium
    - Perspiration (sweat contain lysozymes – attack bacterial cell wall(
  - Exception: *Staphylococcus aureus* in moist area

First line of defense – physical & chemical barriers

- Eyes
  - Blinking of eyelids
  - Tears containing lysozymes
- Outer ear canal
  - Wax contains antibacterial components

First line of defense – physical & chemical barriers

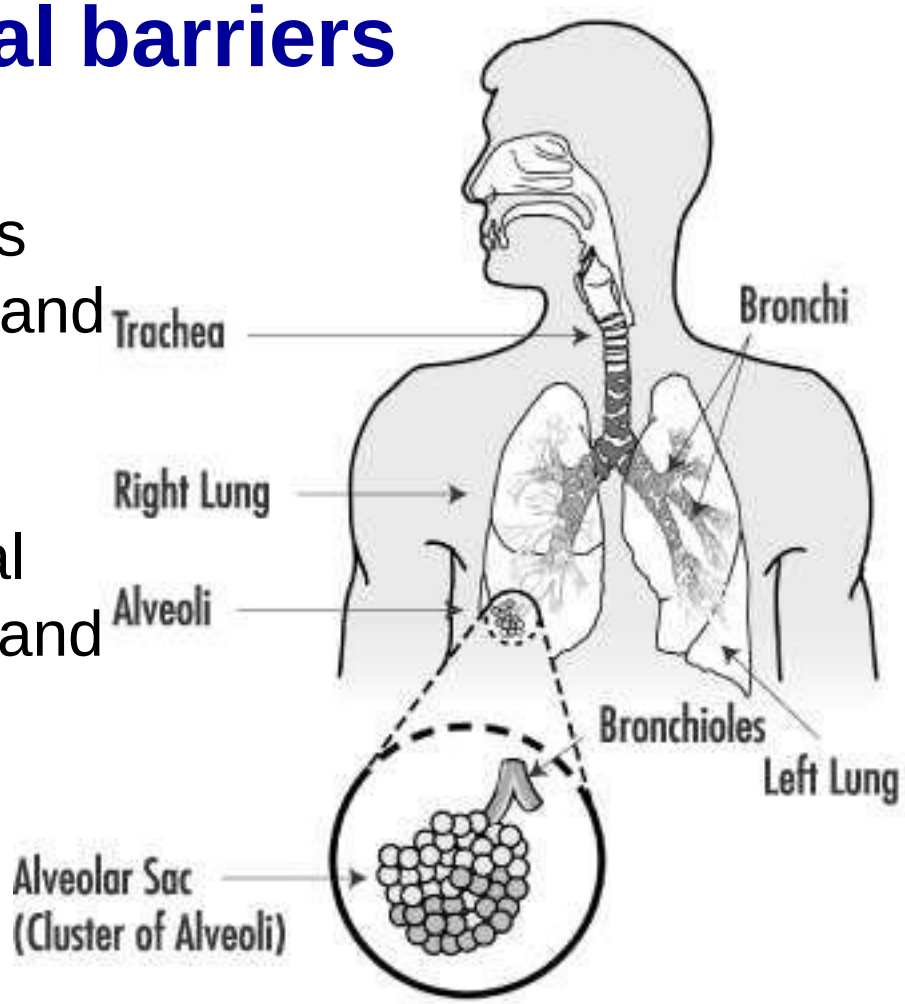
- Mucus membranes – layers of mucosal cells that line body cavities that open to the outside (digestive, genitourinary and respiratory tracts(
  - Mucus is produced by the mucosal cells
    - Contains antimicrobial substance such as lysozymes، lactoferrin (sequester iron(
    - Mucosal cells are rapidly dividing → flush out of body along with attached bacteria

First line of defense – physical & chemical barriers

- Digestive tract
  - Mouth and lower digestive tract – lots of bacteria (mostly anaerobes e.g. *Bacteroides,* anaerobic streptococci [*Streptococcus mutans* in mouth] and *Clostridium* in colon(
  - How؟
    - Mucus
    - Saliva (contains lysozyme(
    - Bile (alkaline) in small intestine
    - Stomach acids
    - Defecation (feces contains up to 50% bacteria(!
    - Mucus contain antibacterial agents, antibodies and immune cells called phagocytes

First line of defense – physical & chemical barriers

- Respiratory tract
  - Nose - nasal hair, mucus secretions (phagocytes and antibacterial enzymes), irregular chambers
  - ciliated epithelium (nasal cavity, sinuses, bronchi and trachea(
  - Cough reflexes
  - Alveolar macrophages



First line of defense – physical & chemical barriers

- Microbial antagonism
  - Normal flora vs. invaders
    - Compete for colonization sites
    - Compete for nutrients
    - Produce bacteriocins
  - Administration of broad spectrum antibiotics may kill only certain members of the normal flora, leaving the others to overgrow → superinfection

Second line of defense

- Once beyond the protective outer barrier of the body, the invading microbes will encounter a series of nonspecific cellular and chemical defense mechanisms

- Mechanisms:
  - Inflammation – a series of events that removes or contain the offending agent and repair the damage
  - Chemotaxis – movement of cells toward a chemical influence)chemokines or chemotatic agents(
  - Phagocytosis – process in which cell ingest foreign particulate matter e.g. microbes

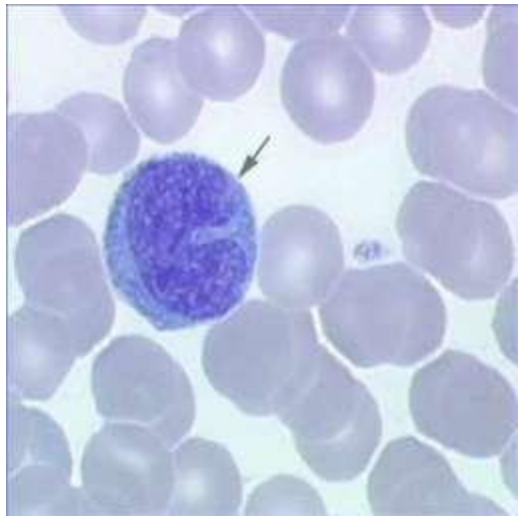
- Many are carried out by the white blood cells in blood

Blood Components

- Fluid portion
  - Serum: liquid portion of clotted blood
  - Plasma: liquid portion with clotting factors
  - “Plasma can clot; Serum cannot”
  - Contains antibodies & other proteins
- Clotting factors (proteins(
  - Fibrinogen
  - Prothrombin
- Formed elements
  - Erythrocytes – red blood cells (RBC) – carry oxygen and carbon dioxide; no nucleus
  - Leukocytes – white blood cells (WBC) - defense
  - Platelets – thrombocyte particles – clotting; no nucleus

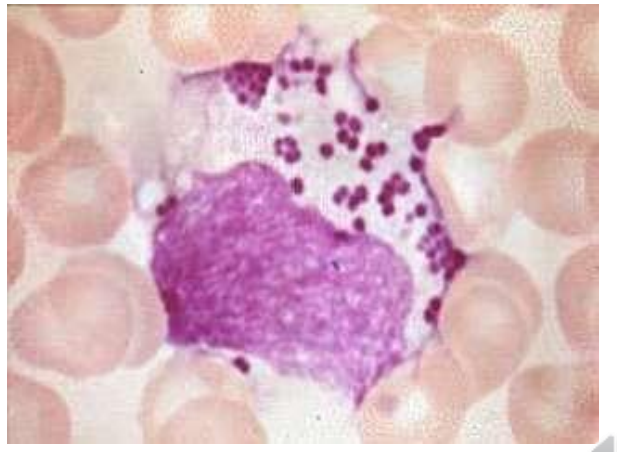
Monocyte (Macrophage(

Monocytes (the blood form(



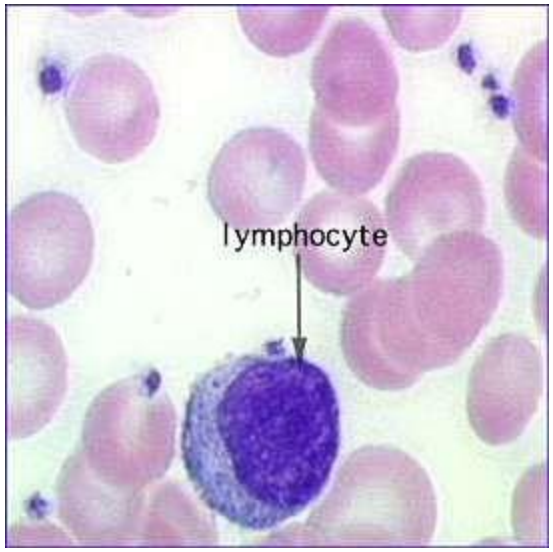
- the largest WBC's normally found in blood
- horseshoe or "U" shape nucleus, or it may be folded
- travel to different tissue to mature into specific macrophage

Macrophage



- As it developed from monocytes, its size can increase 2-3 times
- Wandering – motile and travel in bloodstream; found throughout body
- Fixed (histiocytes)– attached and remain in the tissue
- Removal and engulfment of foreign particles and useless body cells/material

Lymphocytes



•The lymphocyte nucleus is usually round to slightly indented with a sharply defined edge, and deep, dense purple. Cytoplasm may be scant or form a narrow rim around the nucleus.

•Cornerstone of the immune system: antibodies production & cell-mediated immunity

Second line of defense

- Acute phase proteins
  - set of plasma proteins whose level increases during infection to enhance host defense mechanisms
  - e.g. complement proteins, coagulating factors، transferrins

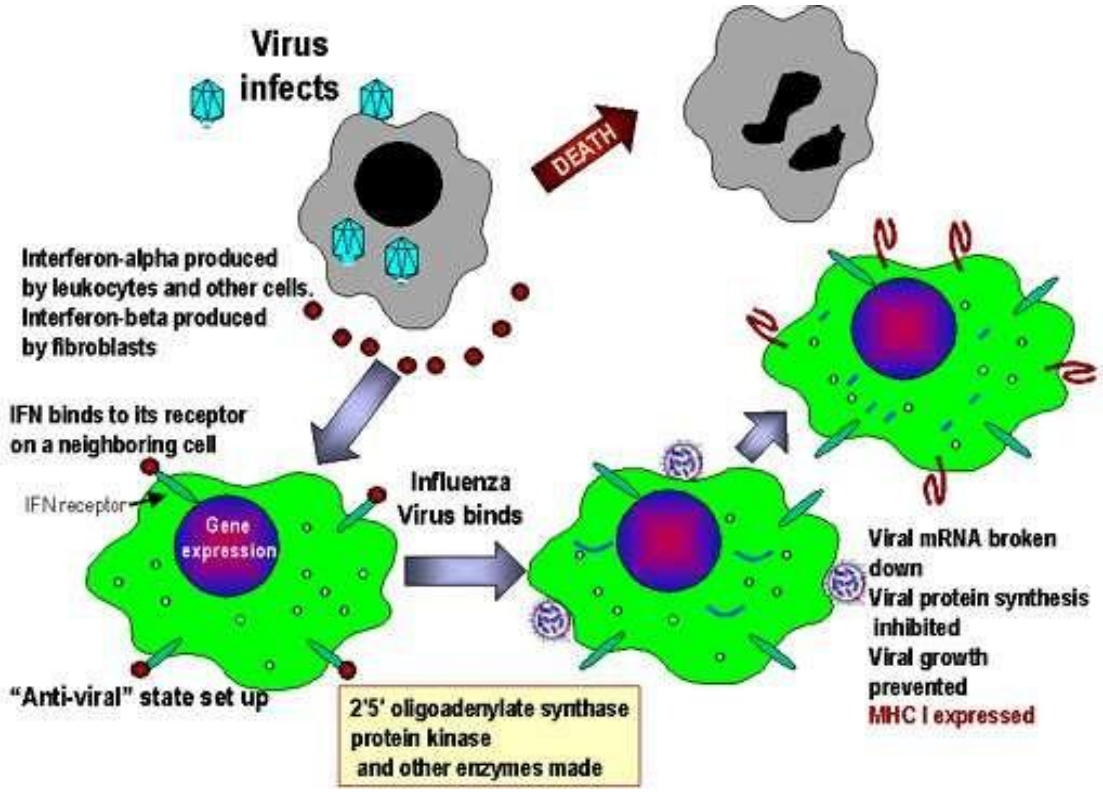
- Cytokines
  - small secreted proteins produced by cells
  - Communication between different defense systems
  - Examples: interleukins, interferons

Second line of defense

- Fever
  - Pyrogens are substances that stimulate fever
    - External, e.g. bacterial endotoxin
    - Internal (endogenous), e.g. interleukins (IL-(1
  - Body temperature increases in response to pyrogens to:
    - Stimulate WBC to deploy & destroy microbes
    - increase in immunological response (e.g. proliferation and activation of lymphocytes(
    - Slow down growth of or kill pathogens

Second line of defense

- Interferons
  - Anti-viral proteins produced by virus-infected cells (eventually died(
  - Alert system to prevent virus from infecting other cells and to stimulate certain lymphocytes



-Has been used a experimental therapy (nowadays, many are genetically engineered) for viral infections and cancers

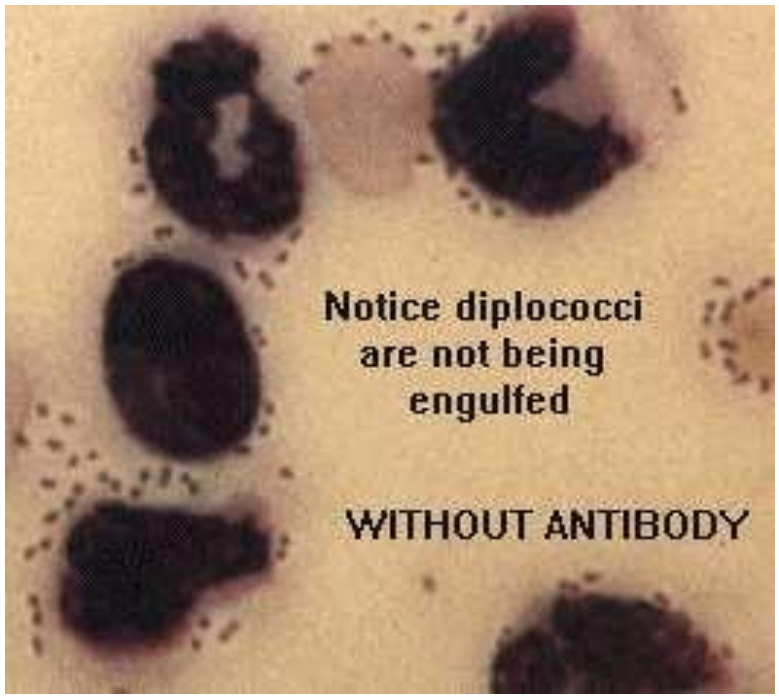
- Species-specific for host cells

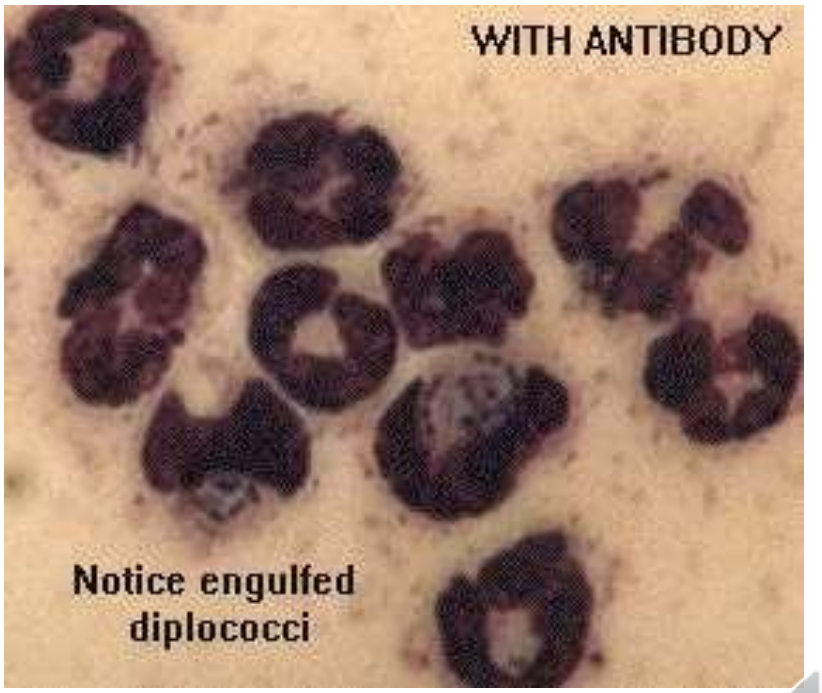
Second line of defense

- The complement systems
  - Consists of ~30 proteins that complement the action of the immune system
  - Functions:
    - Inflammation
    - Stimulate leukocytes
    - Lyse bacteria
    - Increase phagocytosis by opsonization

Opsonization

- Process by which phagocytosis is facilatated by deposition of opsonins
- Opsonins can be complement proteins, or antibodies
- e.g. encapsulated bacteria
- Deficiency in complement system may lead to increase susceptibility to certain infections.



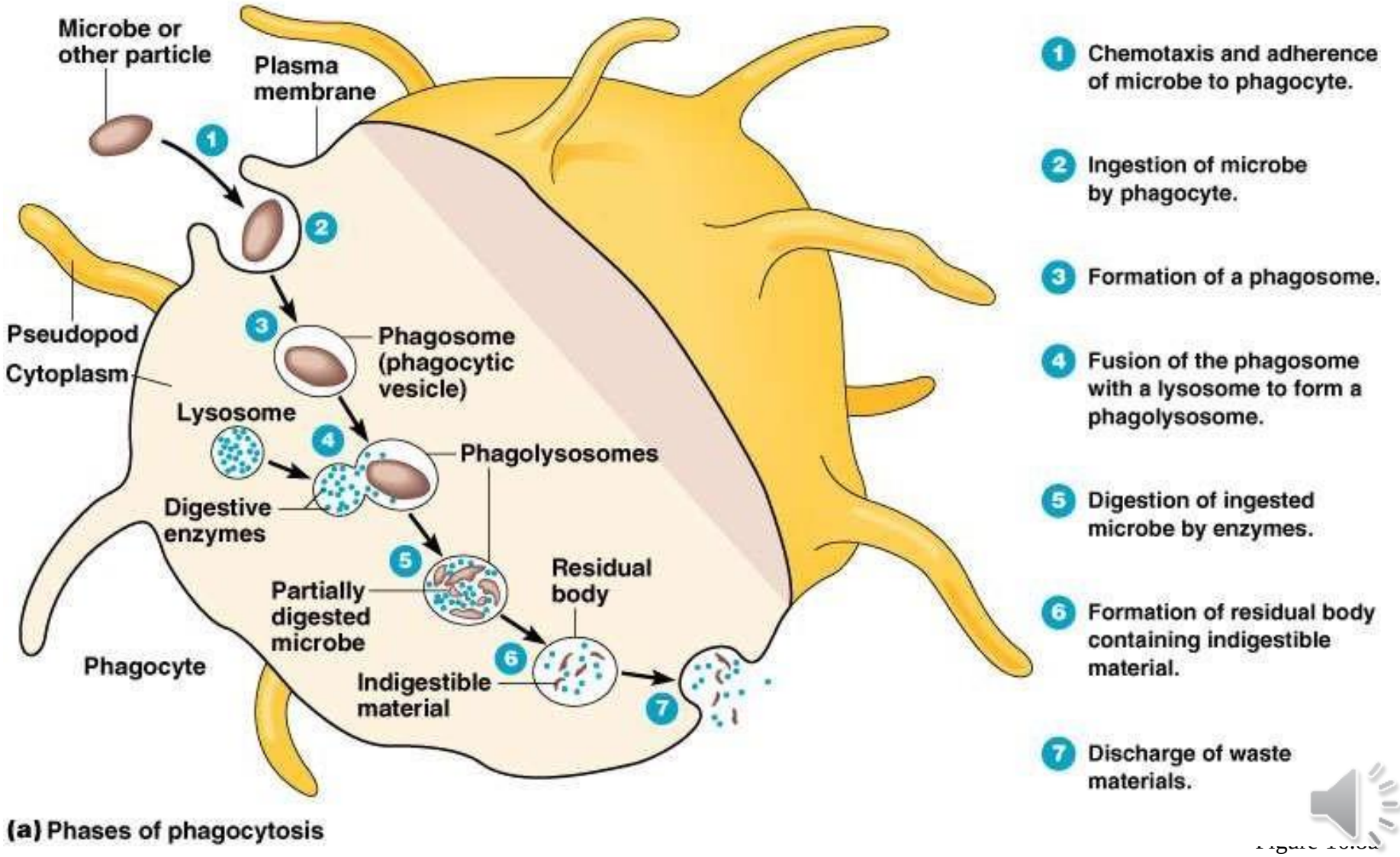


Phagocytosis is the ingestion of microorganisms or other matter by a cell. Many white blood cells engulf invasive microorganisms by the process of phagocytosis. The steps in phagocytosis are:

- .1 ***Chemotaxis*** is the process by which phagocytes are attracted to microorganisms.
- .2 ***Attachment***: The phagocyte then adheres to the microbial cell. This adherence may be facilitated by *opsonization* – coating the microbe with plasma proteins.
- .3 ***Ingestion***: Pseudopods of phagocytes engulf the microorganism and enclose it in a phagosome to complete ingestion.
- .4 ***Digestion***: Lysosomes fuse with the phagosome to form a digestive vacuole. The microbe is killed and digested.

Second Line of Defense

Phagocytosis



(a) Phases of phagocytosis