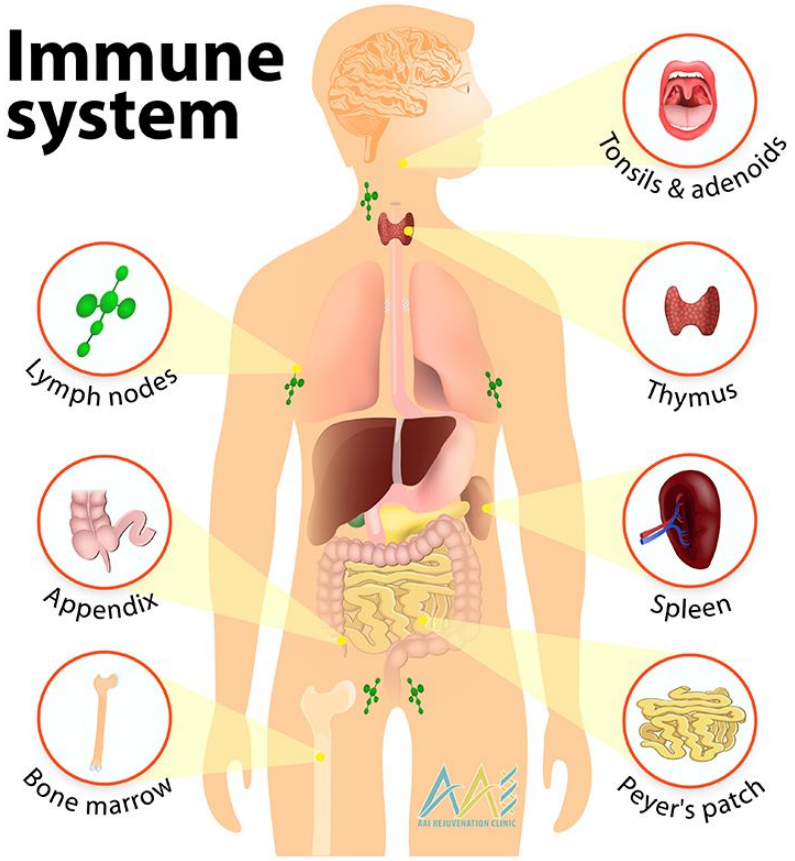
LESSON №14

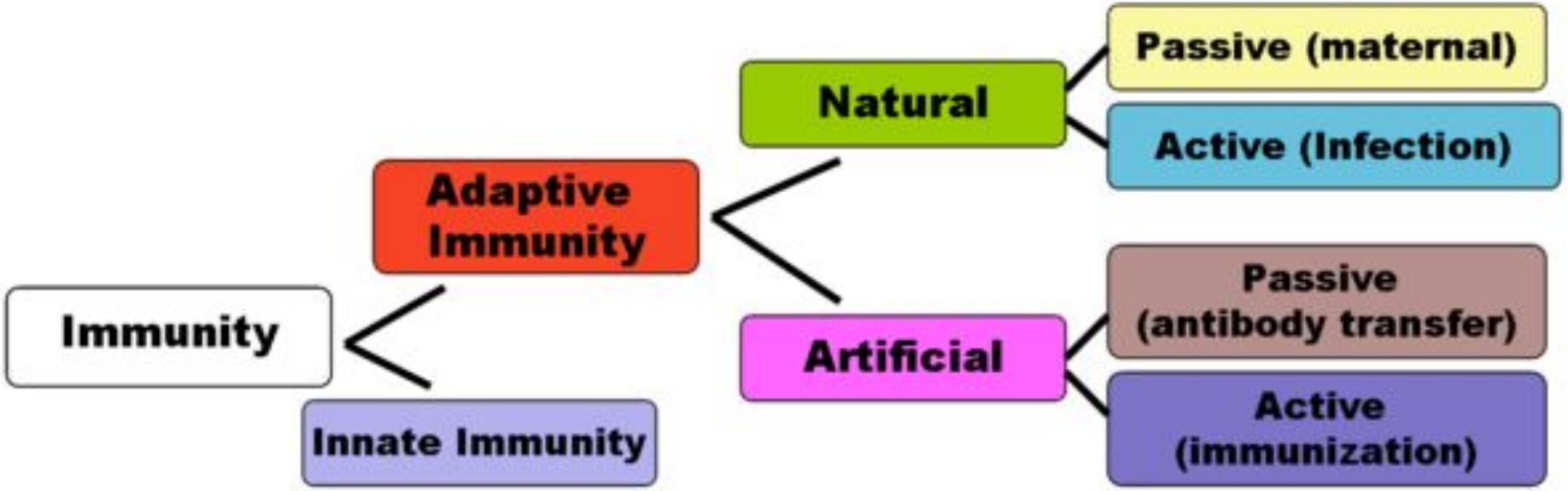
IMMUNITY
NONSPECIFIC RESISTANCE FACTORS AND MECHANISMS
ROLE OF NONSPECTIFIC RESISTANCE FACTORS IN ORAL CAVITY

- Immunity is the capability of multicellular organisms to resist harmful microorganisms from entering it.
- The **immune system** is comprised of the **lymphoid tissues and organs of the body.**



An immune system contains:

- innate components (composed of primitive bone marrow cells that are programmed to recognise foreign substances and react)
- adaptive components (composed of more advanced lymphatic cells that are programmed to recognise self substances and don't react)



Immunity involves

- Specific immunity: the development of antibodies for each of the cases of infection, the ingress of viruses, foreign bodies and the preservation of these cases in memory for a long period or for life.
- Nonspecific (innate) immunity: act as barriers or eliminators of a wide range of pathogens irrespective of their antigenic make-up.

NON-SPECIFIC RESISTANCE FACTORS

Primary barriers of nonspecific protection factors

- ✔ Skin covers the entire body and mechanically protects the body from the penetration of microbes, viruses.
- ✔ Mucous membranes of the nasopharynx, respiratory tract, intestine have even more pronounced protective properties than the skin. In tears, saliva, lysozyme is found, which dissolves many saprophyte microbes, as well as some pathogenic microbes.
- ✔ The normal microflora of the human body has an antagonistic effect on various types of microorganisms.

If microorganisms overcome these barriers, then secondary barriers of nonspecific protection factors come into operation.

NON-SPECIFIC RESISTANCE FACTORS

Secondary barriers of nonspecific protection factors

1. Humoral factors – complement system: is a component of many immunological reactions aimed at freeing the body of microbes and other foreign agents.

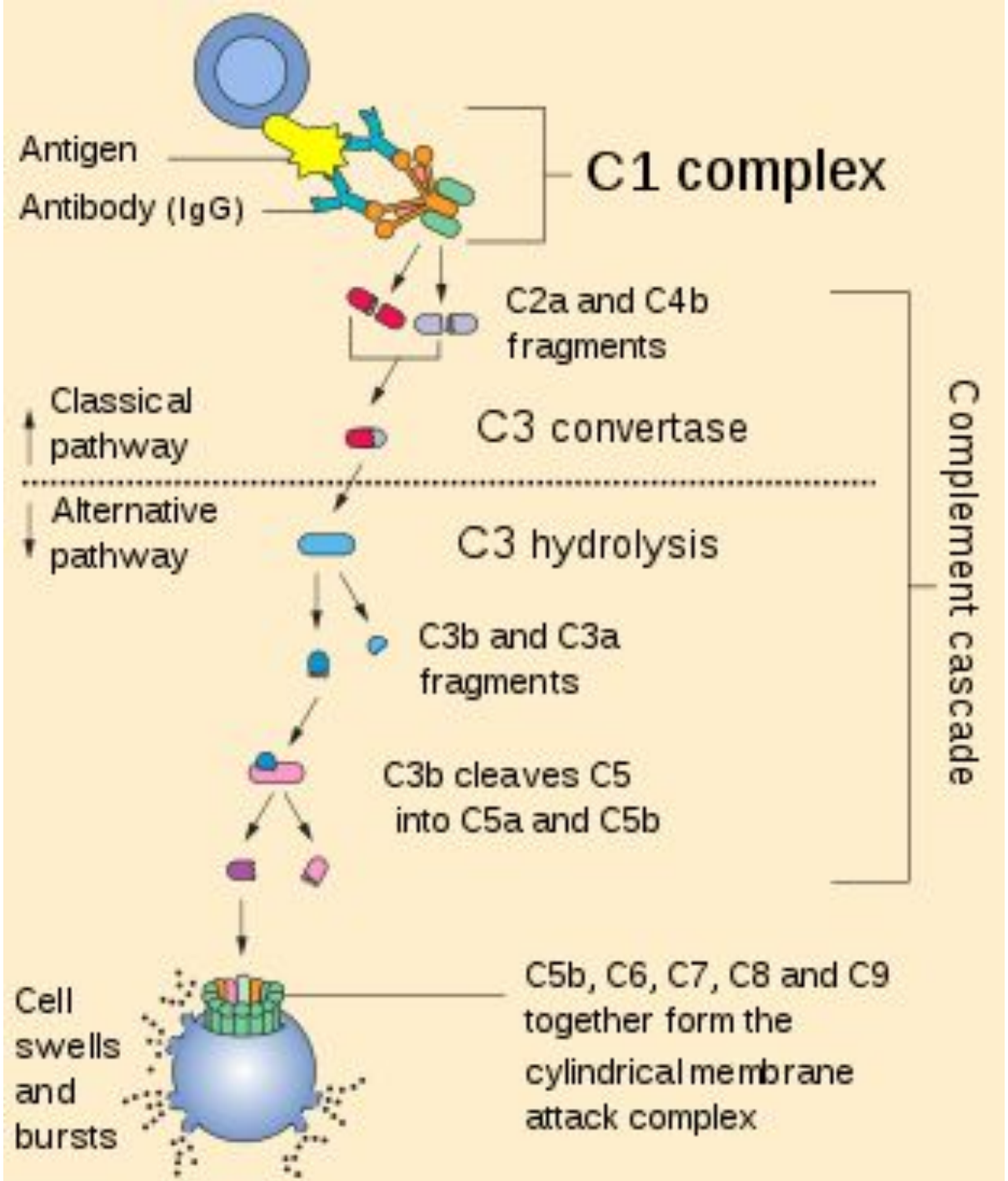
COMPLEMENT SYSTEM

The **complement system** is a part of the immune system that enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from an organism, promotes inflammation, and attacks the pathogen's plasma membrane. It is part of the innate immune system, which is not adaptable and does not change over the course of an individual's lifetime. It can be recruited and brought into action by antibodies generated by the adaptive immune system.

ACTIVATION OF COMPLEMENT

Antibodies combined with the surface of microorganisms or surfaces of Ag activate the complement cascade which has four principal effects related to host defense:

1. Induction of the inflammatory responsechemotactic
2. Attraction of phagocytes to the site of immunological encounter
3. Opsonization of cells showing foreign Ag
4. Complement-mediated lysis of certain bacteria or viruses


Antigen
Antibody (IgG)
C1 complex
C2a and C4b fragments
Classical pathway
C3 convertase
Alternative pathway
C3 hydrolysis
C3b and C3a fragments
C3b cleaves C5 into C5a and C5b
Complement cascade
Cell swells and bursts
C5b, C6, C7, C8 and C9 together form the cylindrical membrane attack complex

NON-SPECIFIC RESISTANCE FACTORS

Secondary barriers of nonspecific protection factors

2. Cellular defense factors – phagocytes. To the phagocytes, Mechnikov referred macrophages and microphages. Currently, all phagocytes are united in a single phagocytic system.

   The functions of phagocyte cells are very diverse:

- ✔ they remove from the body dying cells
- ✔ absorb and inactivate microbes, viruses, fungi
- ✔ synthesize biologically active substances (lysozyme, complement, interferon)
- ✔ participate in the regulation of the immune system.

SUMMARY

The immunological system is able to recognize foreign substances (antigens) which stimulate the system to produce **antibody-mediated immunity (AMI), cell-mediated immunity (CMI),** or both. **AMI** and **CMI** are the two great branches of the immune system.

Genetically foreign substances that, when introduced into the body, can stimulate the immune response (cellular reaction, antibody formation, allergy, tolerance) and specifically react with the formed antibodies both in vivo and in vitro, are called **antigens.**

AN ANTIGEN

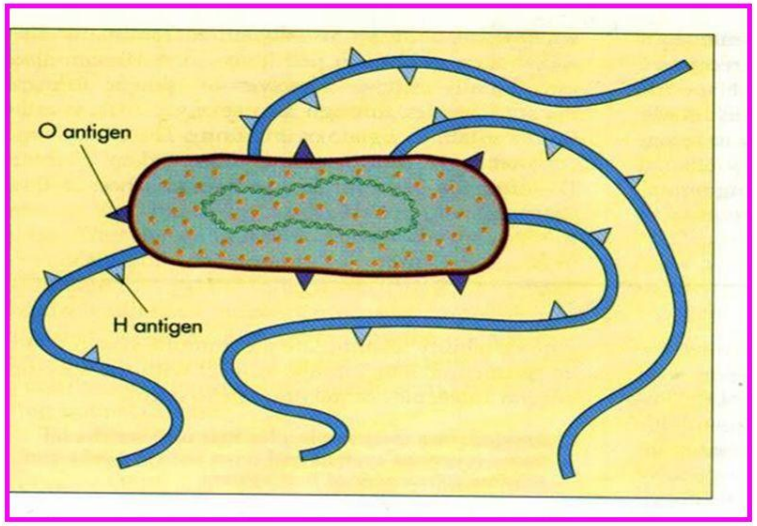
An **antigen** (Ag) is a substance, usually macromolecular, that induces an immunological response. Because of its complex macromolecular structure, a single microorganism consists of multiple antigens. The coat proteins and some of the envelope proteins of animal viruses are also usually antigenic. The host is able to respond specifically to each and every antigen to come into contact with the components of the immunological system.

AN ANTIGEN

Antigens:

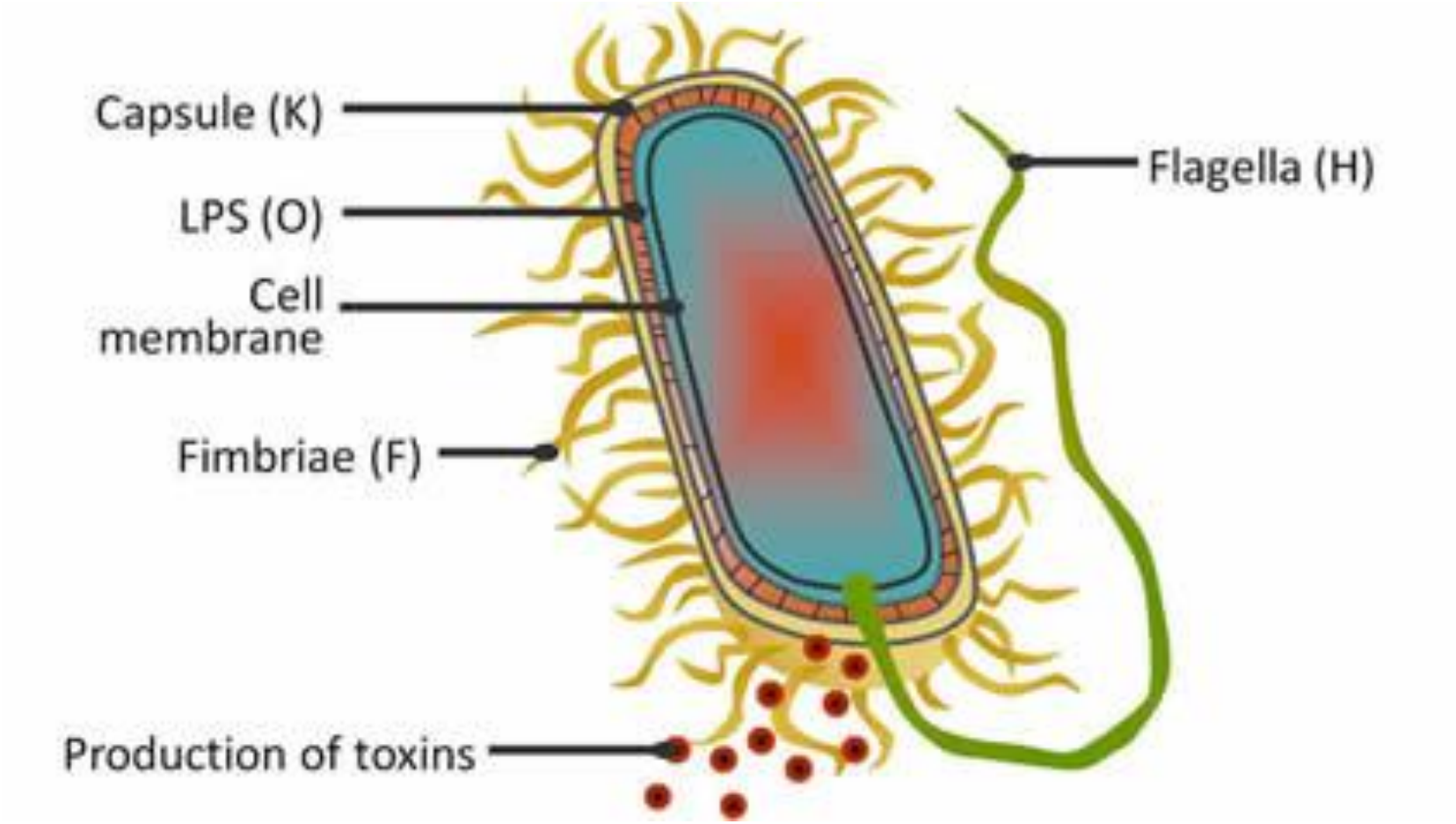
- surface structures such as cell wall components, (fimbriae, flagella, etc.)
- toxins or enzymes produced by the microorganism

Antigenic structure of a bacterium



TASK 1

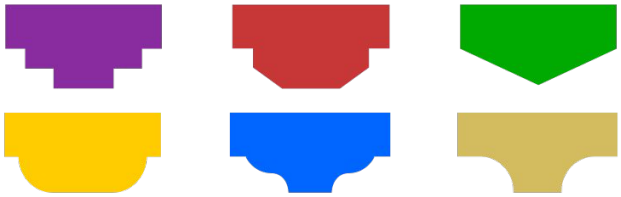
ANTIGENIC STRUCTURE OF A BACTERIAL CELL

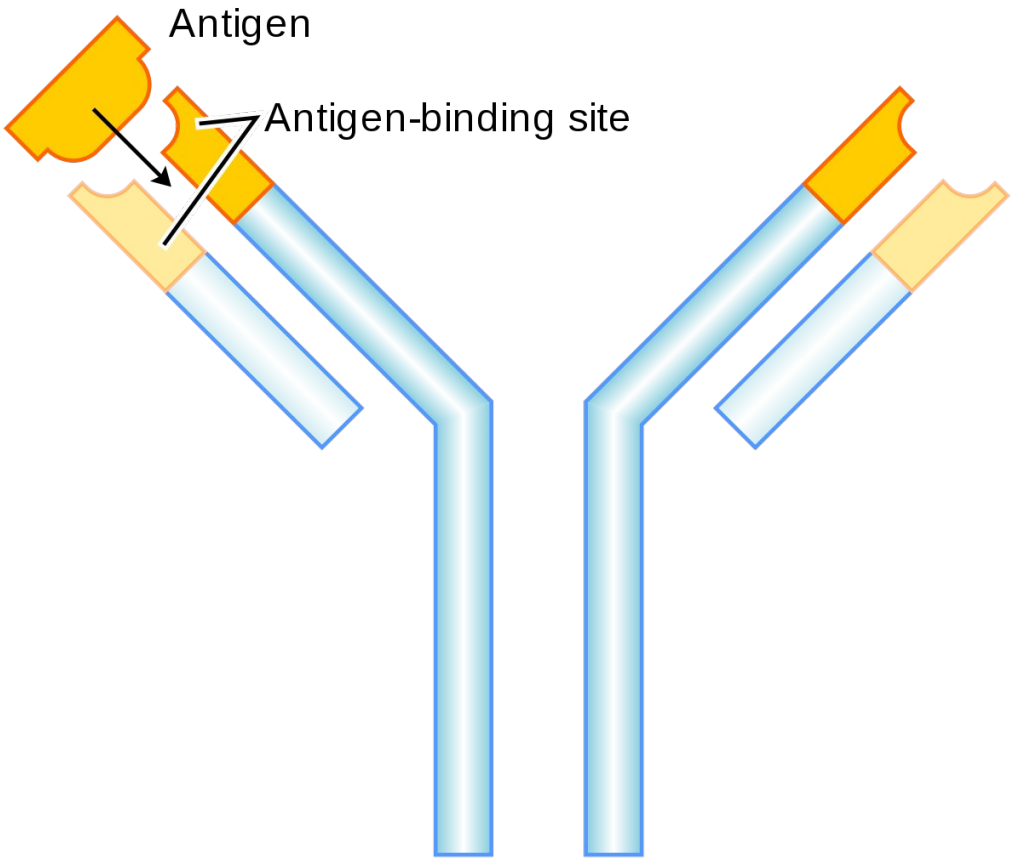


ANTIBODIES (IMMUNOGLOBULINS)

- Antibodies are proteins produced by lymphocytes that can **specifically bind a wide variety of protein and polysaccharide antigens** and elicit a response that is significant in antimicrobial defense.
- In conjunction with the complement system, antibodies are the mediators of humoral immunity, and their presence on mucosal surfaces provides resistance to many infectious agents.
- Antibodies are essential for the prevention and/or cure of many types of bacterial and viral infections.

Antigens





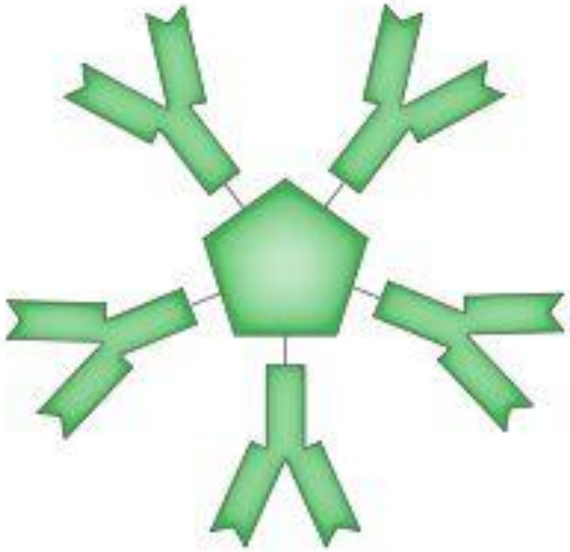
Antibody

ANTIBODIES (IMMUNOGLOBULINS)

- There are a number of types of antibodies or immunoglobulins that react stereochemically and specifically with an antigen that induced their formation.
- Five immunoglobulin classes are defined on the basis of their heavy chain composition, named IgG, IgM, IgA, IgE, and IgD. IgG and IgA are further divided into subclasses.
- Each of these classes of immunoglobulins (abbreviated Ig) is produced by a specific clone of plasma cells. Their synthesis occurs at different stages and rates during an immune response and/or during the course of an infection.
- The classes of immunoglobulins have different physical and chemical characteristics and they exhibit unique biological properties. Their importance and functions in host resistance are different.

Monomer
IgD, IgE, IgG

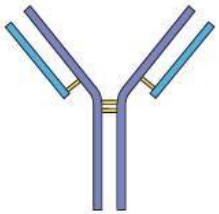
Dimer
IgA



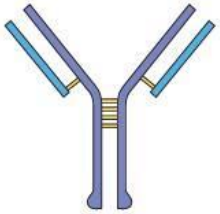
Pentamer
IgM

The five classes of antibodies, or immunoglobulins (Igs)

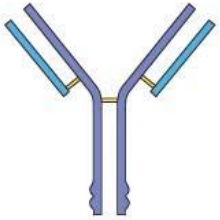
Classes of Antibodies



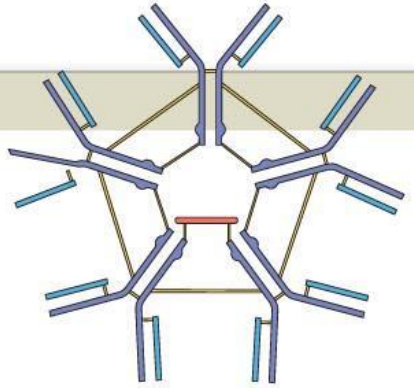
IgG antibodies account for 80 percent of all antibodies. IgG antibodies are responsible for resistance against many viruses, bacteria, and bacterial toxins.



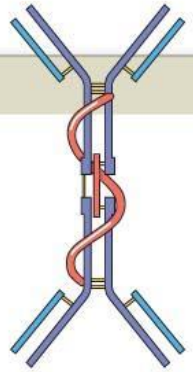
IgE attaches as an individual molecule to the exposed surfaces of basophils and mast cells.



IgD is an individual molecule on the surfaces of B cells, where it can bind antigens in the extracellular fluid. This binding can play a role in the sensitization of the B cell involved.



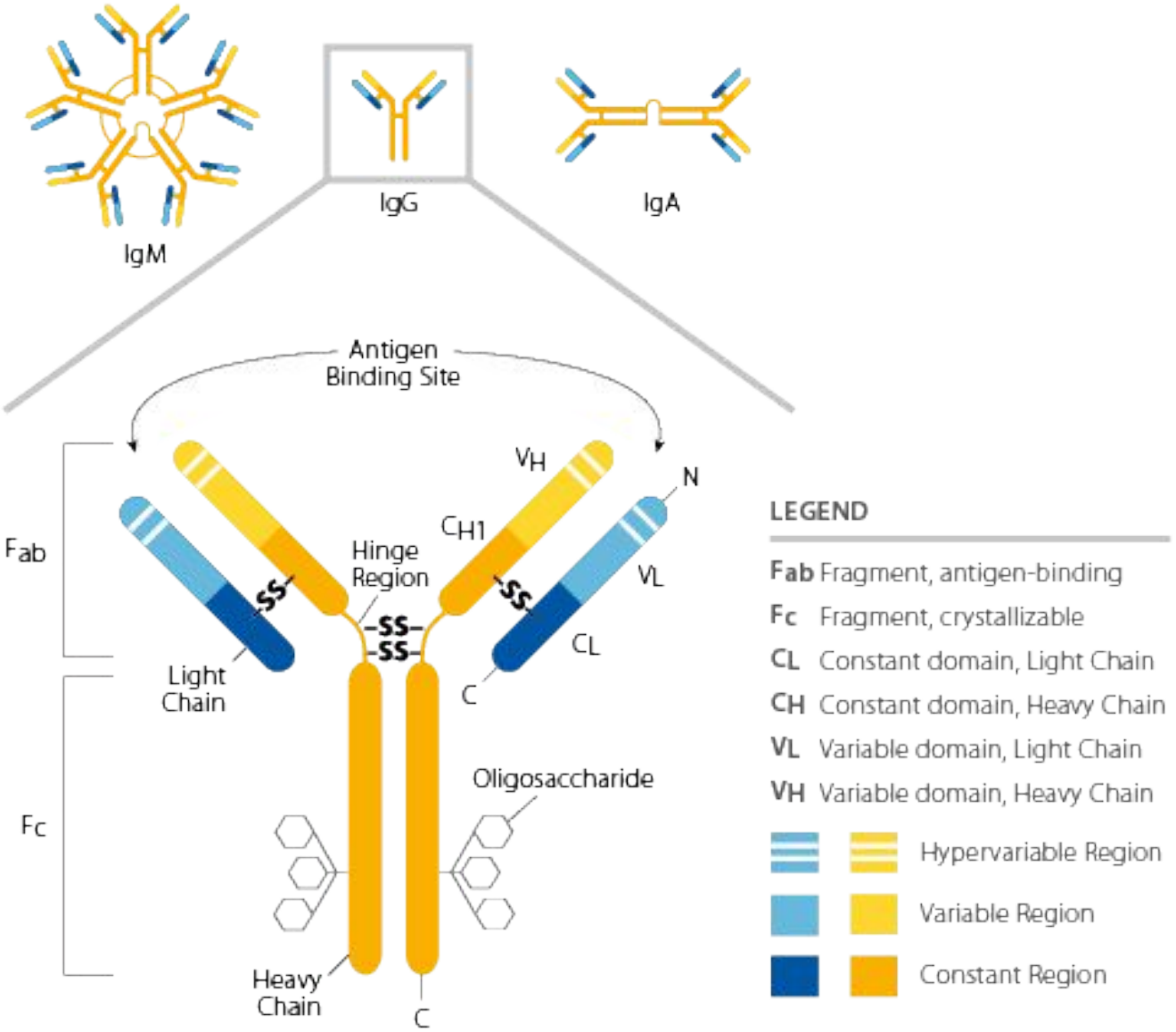
IgM is the first class of antibody secreted after an antigen is encountered. IgM concentration declines as IgG production accelerates. The anti-A and anti-B antibodies responsible for the agglutination of incompatible blood types are IgM antibodies.



IgA is found primarily in glandular secretions such as mucus, tears, saliva, and semen. These antibodies attack pathogens before they gain access to internal tissues.

TASK 2

SCHEME OF IMMUNOGLOBULIN MONOMER STRUCTURE



IgA

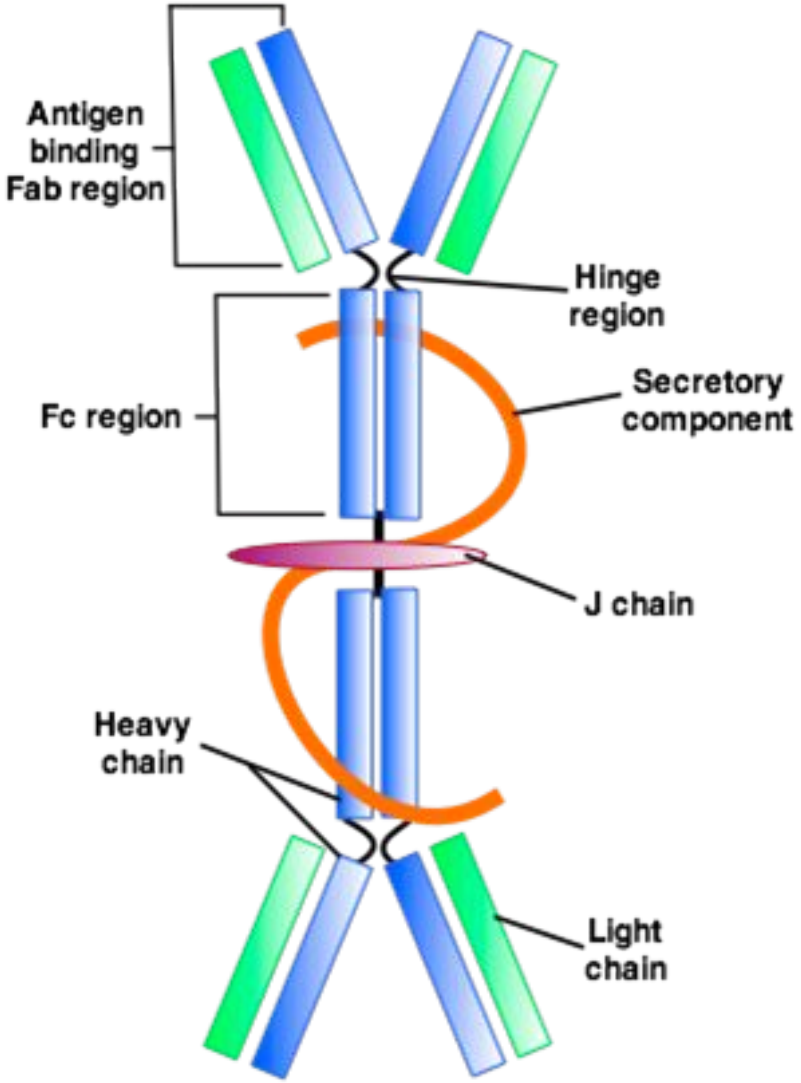
- *IgA* is the predominant immunoglobulin (in GI fluids, nasal secretions, saliva, tears etc)
- IgA antibodies are important in resistance to infection of the mucosal surfaces (respiratory, intestinal and urogenital tracts)
- IgA acts as a protective coating for the mucous surfaces against microbial adherence or initial colonization and can also neutralize toxin activity on mucosal surfaces.
- Fc receptors for IgA-coated microorganisms found on monocytes and neutrophils derived from the respiratory mucosa, suggest that IgA may have a role in the lung, at least, in opsonization of pathogens.

IgA

- IgA is also transferred via the milk from a mother to a newborn, which provides passive immunity to many pathogens, especially those that enter by way of the GI tract
- In humans there are two types of IgA, predominantly **IgA1**, found in serum and derived in bone marrow, and **IgA2**, a secretory form of IgA (small differences in chemical structure)

TASK 3

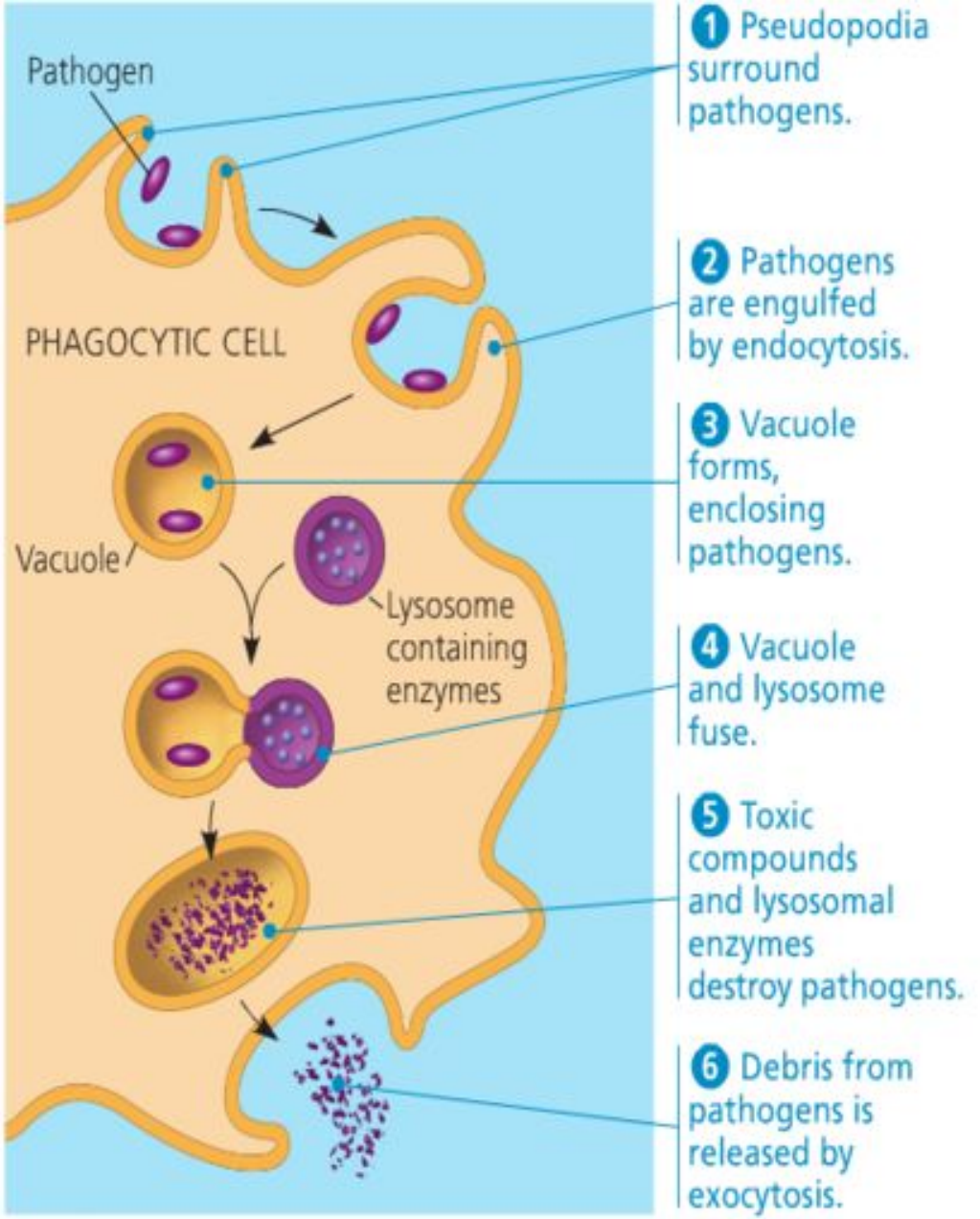
STRUCTURE AND CHARACTERISTIC OF IgA



- ✔ IgA is glycoprotein
- ✔ IgA can be oligomeric, comprised of 2–4 IgA monomers (here dimeric)
- ✔ IgA includes a 15KD joining chain (**J chain**) and a 70KD **secretory component** chain produced in epithelial cells and involved in the transcellular transport of IgA

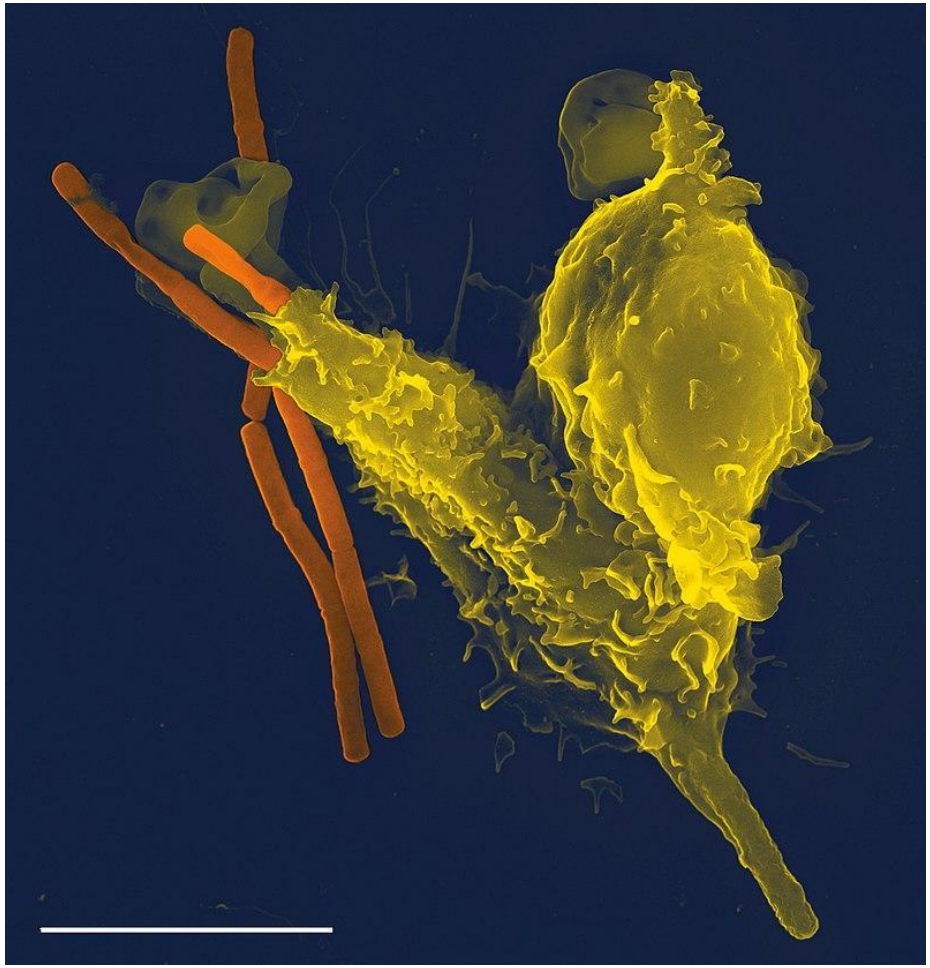
PHAGOCYTOSIS

Phagocytes are the soldiers of the immune system, and provide **innate immunity**. They are responsible for swallowing, killing and digesting invading microbes. The process of swallowing microbes is known as **phagocytosis**.



▲ **Figure 43.3 Phagocytosis.** This schematic depicts events in the ingestion and destruction of a microbe by a typical phagocytic cell.

PHAGOCYTOSIS



A photomicrograph of the neutrophil of a phagocytizing *Bacillus anthracis* cell (orange). Scanning electron microscopy

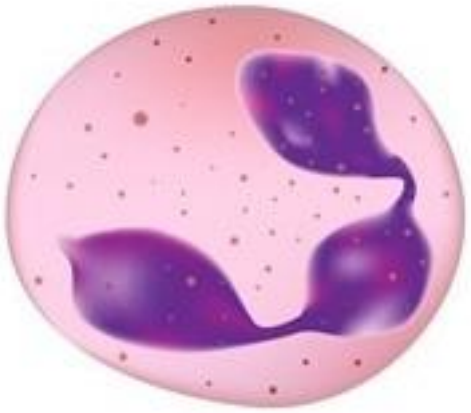
PHAGOCYTES

Phagocytosis is carried out by two types of cells: circulating in the blood granular leukocytes (granulocytes) and tissue macrophages.

In humans, there are two types of professional phagocytes:

✔neutrophils

✔monocytes



Neutrophil

Monocyte

IMMUNE AND NON-IMMUNE PHAGOCYTOSIS

- Immune phagocytosis is absorption by phagocytes of the antigens that make up the immune complexes. Antigens can be either individual molecules or their aggregates, or whole cells or their debris. For the implementation of immune phagocytosis, the participation of immunoglobulin molecules and / or complement is necessary.
- Non-immune phagocytosis: macrophages are capable of phagocytizing foreign particles, microorganisms and the remains of damaged cells directly, without calling an immune response.

INCOMPLETE PHAGOCYTOSIS

Phagocytosis must be completed by the complete destruction of the harmful object. They must, but do not always end. In the latter case, phagocytosis is called incomplete.

The phenomenon of incomplete phagocytosis occurs if the phagocyte "attacks", absorbs the object, but can not digest it. Usually this happens to living harmful agents: bacteria, fungi, viruses. As a rule, the causes of phagocytosis of an incomplete type lie in the characteristics of the pathogen itself. Less often they are caused by defects in human immunity.

TASK 4

A PREPARATION WITH INCOMPLETE PHAGOCYTOSIS

Passive defenses: incomplete phagocytosis

- Some pathogens can block their degradation and remain alive inside the phagocyte.

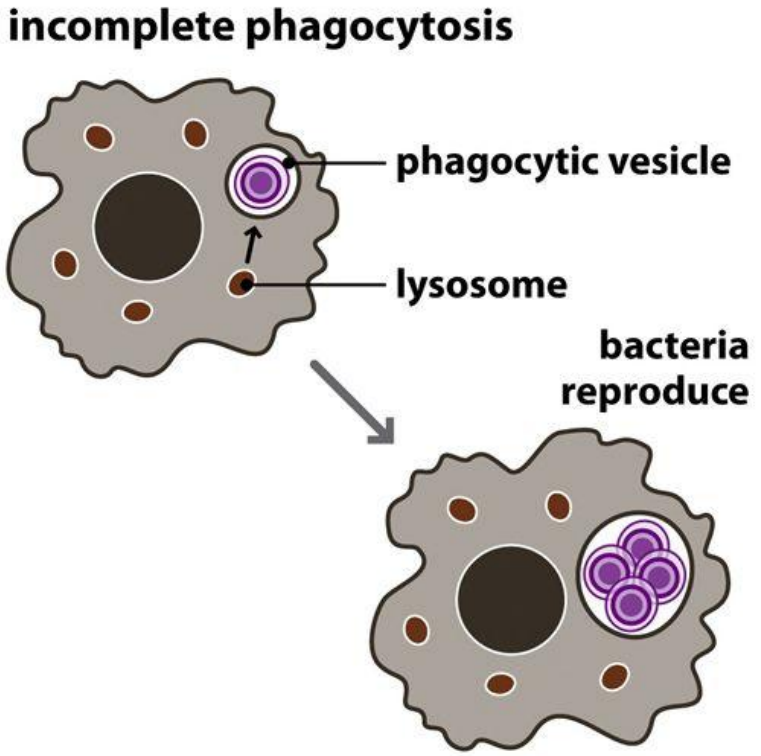
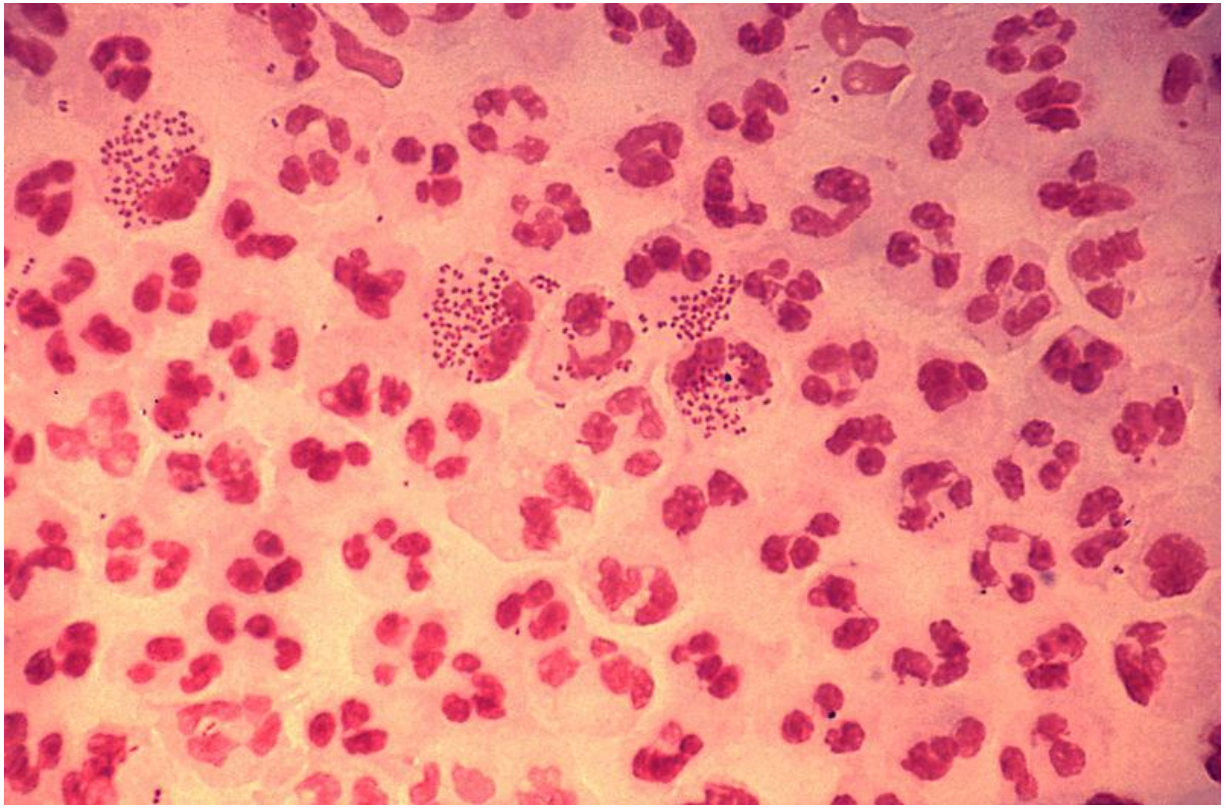


Figure 5.13b Microbiology: A Clinical Approach (© Garland Science)

TASK 4

A PREPARATION WITH INCOMPLETE PHAGOCYTOSIS



Micrograph of Gram-stained pus showing *Neisseria gonorrhoeae* bacteria inside phagocytes and their relative sizes

LOCAL IMMUNITY OF ORAL CAVITY

- The oral cavity is the "entrance gate" for pathogens.
- Practical experience shows that diseases of the oral mucosa occur much less frequently than would be expected. This is due to the peculiarities of the structure of the mucous membrane and the precence of powerful mechanisms that prevent the development of the inflammatory process.

LOCAL IMMUNITY OF ORAL CAVITY

barrier-protective function

non-specific resistance factors

- structure features of the mucosa
- colonization resistance
- lymphocytes, macrophages
- desquamation (exfoliation) of buccal epithelium

specific resistance factors

- IgA fixed on mucous membrane

protective function of saliva

non-specific resistance factors

- lysozyme
- lactoferrin
- peroxidase
- beta-lysine
- interferon
- mucin
- nuclease
- etc.

specific resistance factors

- IgA