



IMMUNITY

55.1 INTRODUCTION

The term “immunity” is referred to the resistance of an individual towards injury caused by microorganisms and their products.

Immunity against infections is of different types which will be dealt in detail in following sections.



OBJECTIVES

After reading this lesson, you will be able to:

- describe the concepts of innate immunity and acquired immunity
- list the types of innate immunity and acquired immunity
- explain the mechanism of innate immunity
- explain the differences between active and passive immunity

55.2 INNATE IMMUNITY : RESISTANCE TO INFECTIONS THAT AN INDIVIDUAL POSSESSES DUE TO HIS GENETIC MAKEUP

Nonspecific immunity – It indicates a degree of resistance to infections in general.

- Species immunity – Refers to the resistance to a pathogen shown by all members of a species for example all human beings are totally unsusceptible to plant pathogens.
- Racial immunity – Different races within a species, may show differences in susceptibility to infections for example in some parts of Africa resistance to *Plasmodium falciparum* malaria is seen.

- Individual immunity – It is the difference in innate immunity shown by different individuals within a race. Several factors such as age, hormones and nutrition influence the level of innate immunity in an individual.

Age: The very young and very old are more prone to infectious diseases than the rest. The fetus in utero is normally protected by placental barrier. But some pathogens cross this barrier. Some, such as rubella virus, herpes viruses, cytomegaloviruses and parasite *Toxoplasma gondii*, can lead to congenital infections. The increased susceptibility of the fetus to infection is due to immaturity of its immune system.

Old persons are more susceptible to infections due to their waning immune responses and other factors, like enlarged prostate leading to stasis of urine.

Hormonal influences: Endocrine disorders like diabetes mellitus are associated with increased risk of infections. The increased risk may be related to increased levels of carbohydrate in tissues.

Corticosteroids depress the individuals resistance by its anti inflammatory and anti phagocytic effects. The effect of stress in increasing susceptibility to infections may be due to release of steroids.

Nutrition: Both cell mediated and antibody mediated immune responses are depressed when there in malnutrition. Cell mediated immune responses such as Mantoux test for tuberculosis becomes negative in severe protein deficiency, as in kwashiorkor.

Specific immunity – It refers to the resistance to a particular pathogen.

- Species
- Racial
- Individual

55.3 MECHANISM OF INNATE IMMUNITY

Epithelial surfaces: The intact skin and mucous membrane covering the body protect it against invasion of microorganisms.

The bactericidal activity of skin secretions can be illustrated by frequent fungal and bacterial infections in individuals who immerse their hands in soapy water for long periods of time occupationally for example washer men.

The mucosa of respiratory tract has several innate mechanism of defence. The structure of nose prevents entry of microorganism to a large extent, inhaled particles being arrested at or near nasal orifices. Those that pass beyond are held by mucous lining the epithelium, and are swept back to mouth were they tend





to be swallowed or coughed out. The cough reflex is an important defence mechanism. The cilia on the respiratory epithelial cells propel particles upwards. Nasal and respiratory secretions contain substances that combine with influenza and some other viruses. Particles that manage to reach alveoli are ingested by alveolar macrophages.

The mouth is continuously bathed by saliva which has inhibitory effect on many microorganisms. Particles deposited in the mouth are swallowed and subjected to action of digestive juices and high acidity of stomach. The intestinal mucosa is covered by lacelike network of mucus. Particles get trapped in the mucus and form small masses which are propelled by peristalsis.

The conjunctiva is freed of foreign particles by flushing action of lachrymal secretions. The eye becomes susceptible to infection when lachrymal secretions are absent. Tears contain antibacterial substance lysozyme, which acts on cell walls of susceptible bacteria.

The flushing action of urine eliminates many bacteria from the urethra. Zinc present in semen has antibacterial activity. The acidity of adult vagina makes it resistant to many pathogens.

Antibacterial substances in blood and tissues: Blood components like complement system possesses bactericidal activity. Several substances like beta lysine, leukins, plakins in blood and lactic acid in muscle tissue, possess antibacterial properties.

A method of defence against viral infections is the production of interferon by cells stimulated by live or killed viruses.

Microbial antagonisms: The skin and mucous membrane have resident bacterial flora which prevents colonisation by pathogens. Alteration of normal resident flora may lead to invasion by pathogenic microorganisms, causing serious diseases such as staphylococcal intestinal infections following oral antibiotics.

Cellular factors in innate immunity: Natural defence against the invasion of blood and tissues by microorganisms and other foreign particles is mediated to a large extent by phagocytic cells which ingest and destroy them. Phagocytic cells are macrophages and neutrophils. Macrophages consists of histiocytes in tissues, the reticuloendothelial cells and monocytes in blood. Phagocyte reach the site of inflammation in large numbers attracted by chemotactic substances, and ingest particulate material. Microorganisms are more readily phagocytosed when trapped against a firm surface like alveolar wall than when they are free in tissue fluids. Bacteria are phagocytosed into a vacuole (phagosome), which

with lysosomes to form phagolysosomes. The bacteria are subjected to the action of the lytic enzymes in the phagolysosomes and are destroyed. Some bacteria like lepra bacilli resist intracellular digestion and may multiply inside phagocytes.

A class of lymphocytes called natural killer (NK) cells are important in defence against viral infections and tumours.

Inflammation: Tissue injury or irritation initiated by the entry of pathogens or other irritants, leads to inflammation. The arterioles at the site constrict initially and then dilate leading to an increase in blood flow. There is a slowing of blood flow and margination of the leucocytes, which escape into the tissues and accumulate in large numbers, attracted by the chemotactic substances released at the site of injury. Microorganisms are phagocytosed and destroyed.

Fever: A rise of temperature following infection is a natural defence mechanism. Therapeutic induction of fever was used in syphilis patients before use of penicillin.

Acute phase proteins: Infection or injury leads to a sudden increase in the plasma concentration of certain proteins, collectively called acute phase proteins. These include C reactive protein (CRP). They are believed to enhance host resistance, prevent tissue injury and promote repair of inflammatory lesions.

Section 1.02 Acquired immunity: The resistance that an individual acquires during life is known as acquired immunity.

Acquired immunity is of two types:

Active immunity

- Natural
- Artificial

Passive immunity

- Natural
- Artificial

Active immunity is the resistance developed by an individual as a result of an antigenic stimulus.

- This involves the active functioning of the host's immune apparatus leading to the synthesis of antibodies and the production of immunologically active cells.
- Active immunity sets in after a latent period which is required for the immunological machinery to set in motion.



Notes



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- Once developed active immunity is long standing.
- If an individual who has been actively immunised against an antigen is exposed to same antigen again, the immune responses occur quickly and abundantly than during the first encounter. This is known as *secondary response*.
- Active immunity is associated with immunological memory. This means that the immune system is able to retain for long periods the memory of prior antigenic exposure.
- Active immunity confers better protection than passive immunity.

Active immunity can be natural or artificial. **Natural** active immunity results from either a clinical or an inapparent infection by a microorganism. Such immunity is usually long lasting but the duration varies with the type of pathogen.

- Immunity is lifelong following viral diseases like measles and chickenpox.
- In influenza immunity is short lived due to antigenic variation, so as to immunity following the first infection is not effective against second infection caused by antigenically novel virus.
- In syphilis, a special type of immunity known as 'premunition' is seen. Here, the immunity to reinfection lasts only as long as original infection remains active.

Artificial active immunity is the resistance induced by the vaccines. Vaccines are preparations of live or killed microorganisms or their products used for immunisation.

Examples of vaccines are as follows:

Bacterial vaccines – live (BCG for tuberculosis), bacterial products (Tetanus toxoid)

Viral vaccines – live (Oral polio vaccine *Sabin*), killed (Injectable polio vaccine *Salk*), subunit (Hepatitis B vaccine)

Live vaccines initiate an infection without causing any injury or disease. The immunity following live vaccine parallels that after natural infection though it may be of lower order. Killed vaccines are generally less immunogenic than live vaccines, and protection lasts only for a short period. They therefore, to be given repeatedly; generally at least two doses are required. The first dose is called **primary dose** and the subsequent doses as booster doses.

Passive immunity is the resistance transmitted passively to an individual in a 'readymade' form.

Immunity

- There is no antigenic stimulus; instead, preformed antibodies are administered.
- There is no latent period, protection being effective immediately.
- The immunity is transient, no secondary response in passive immunity.
- It is less effective than active immunisation.
- The main advantage of passive immunisation is that it acts immediately and, therefore, can be used when immediate effect is desired, for example antidiabetic serum given to a child presenting with diphtheria.

Natural passive immunity is the resistance passively transferred from mother to baby. In the human infants, maternal antibodies are transmitted predominantly through the placenta. It is only by the age of three months that the infant acquires some measure of immunological independence.

Artificial passive immunity is the resistance passively transferred to a recipient by the administration of antibodies. The agents used for this purpose are hyperimmune sera of animal or human origin (Anti tetanus serum, ATS, prepared from hyperimmune horses) and pooled human gammaglobulin (tetanus immunoglobulin, TIG).

Sometimes a combination of active and passive immunisation is used, known as *combined immunisation*. For example, protection of a nonimmune individual with a tetanus prone wound (both TIG and Tetanus toxoid is given).

A special type of immunisation is the injection of immunologically competent lymphocytes, known as *adoptive immunity*.

Measurement of immunity

A simple method of testing immunity is to relate its level to some convenient indicator, such as demonstration of the specific antibody. The antibodies may be demonstrated by a variety of techniques such as agglutination, precipitation, complement fixation, hemagglutination inhibition, neutralisation, enzyme linked immunosorbent assay (ELISA). Where protection is associated with cell mediated immunity, skin tests for delayed hypersensitivity and in vitro tests are used as an indicator of immunity

Local immunity

In poliomyelitis systemic immunity provided by active immunisation with the killed vaccine neutralises the virus when it enters the bloodstream, but it does not prevent multiplication of virus at the site of entry (the gut mucosa) and its fecal shedding. This is achieved by local intestinal immunity either acquired by infection or immunisation with live oral vaccine. A special class of immunoglobulins (IgA) forms the major component of local immunity.

MODULE

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**Herd immunity**

This refers to the overall level of immunity in a community. When a large proportion of individuals in a community (*herd*) are immune to a pathogen, the herd immunity to the pathogen is satisfactory. Eradication of communicable diseases depends on the development of a high level of herd immunity rather than on the development of a high level of immunity in individuals.

**INTEXT QUESTIONS 55.1**

1. Difference in innate immunity shown by different individuals within a race is known as
 - a) Individual immunity
 - b) Racial immunity
 - c) Species immunity
 - d) Herd immunity
2. Immunoglobulin which forms the major component of local immunity is
 - a) IgM
 - b) IgG
 - c) IgA
 - d) IgE
3. BCG vaccine for tuberculosis is a type of
 - a) Killed vaccine
 - b) Live vaccine
 - c) Subunit vaccine
 - d) None of the above
4. The resistance passively transferred to a recipient by the administration of antibodies is known as
 - a) Artificial active immunity
 - b) Natural active immunity
 - c) Artificial passive immunity
 - d) Natural passive immunity

5. Maternal antibodies transferred to fetus through placenta provides
 - a) Artificial active immunity
 - b) Natural active immunity
 - c) Artificial passive immunity
 - d) Natural passive immunity
6. Immunity is lifelong after first episode of following viral disease
 - a) Syphilis
 - b) Measles
 - c) Influenza
 - d) Tuberculosis
7. A special type of immunity 'premunition' is seen in
 - a) Polio
 - b) Hepatitis
 - c) Syphilis
 - d) Chickenpox
8. All of them are phagocytic cells except
 - a) Neutrophils
 - b) Macrophages
 - c) Histiocytes
 - d) Platelets

**WHAT YOU HAVE LEARNT**

- The term "immunity" is referred to the resistance exhibited by the host towards injury caused by microorganisms and their products.
- Immunity against infections is of different type's innate immunity and acquired immunity.
- Innate immunity is the resistance to infections that an individual possesses by virtue of his genetic makeup, and can further be grouped as:
 - Nonspecific immunity: Indicates a degree of resistance to infections in general.
 - Species immunity – Refers to the refractoriness to a pathogen shown by all members of a species.



MODULE

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Immunity

- Racial immunity – Within a species, different races may show differences in susceptibility to infections.
- Individual immunity - It is the difference in innate immunity shown by different individuals within a race
- Specific immunity: Refers to the resistance to a particular pathogen, and can also be divided into species, racial and individual immunity.
- In mechanism of innate immunity epithelial surfaces of skin and mucosa, antibacterial substances in blood and tissues, microbial antagonism and cellular mediators have an important role. In addition to that physiological and pathological responses like fever, inflammation and rise in acute phase reactants; contribute to innate immune response.
- Acquired immunity is the resistance that an individual acquires during life. Acquired immunity is of two types:
- Active immunity is the resistance developed by an individual as a result of an antigenic stimulus. Passive immunity is the resistance transmitted passively to an individual in a 'readymade' form. Both can be subdivided into natural and artificial.
- Local immunity refers to the protection given to a potential site of entry for a pathogen; such immunity prevents entry of pathogen.
- Herd immunity is the immunity developed in a large proportion of individuals in a population. This is important in decreasing likelihood of epidemics.



TERMINAL QUESTIONS

1. Discuss the type and mechanism of innate immunity
2. What are the differences between active and passive immunity? Describe with examples.
3. Define local immunity and herd immunity.



ANSWERS OF INTEXT QUESTIONS

55.1

1. (a)
2. (c)
3. (b)
4. (c)
5. (d)
6. (b)
7. (c)
8. (d)