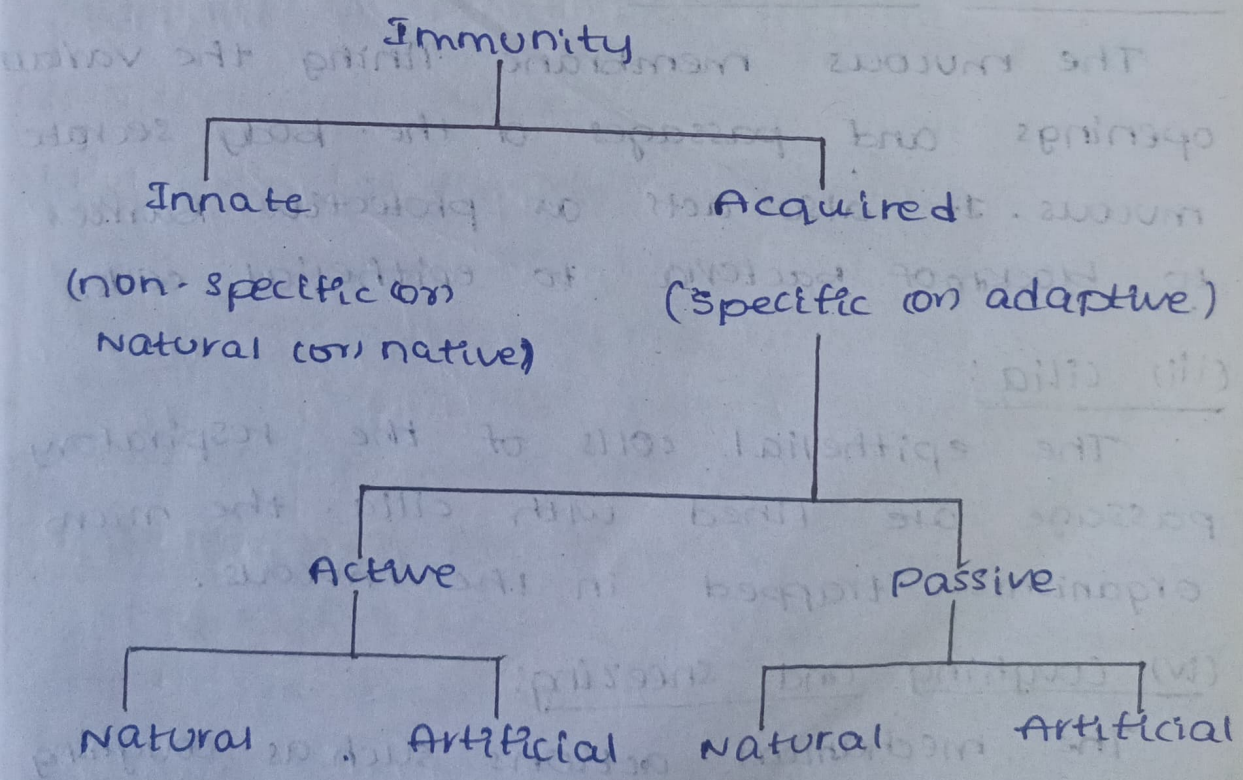
Unit-1 : Immune System

Immunity:

Immunity is defined as the resistance to infection. this is carried out by the process of recognition and disposal of non-self or foreign material that enters the body. the non-self is the life threatening infectious microorganisms or it may be tissue grafts.

Immunity is broadly classified into two types, namely innate immunity and acquired immunity.



Classification of Immunity

(1) Innate Immunity:

All living organisms are naturally gifted with the resistance to certain infections from birth and this natural defence mechanism is known as innate immuntity (or) native immunity (or) natural immuntity

Factors of innate immunity

(A) Physical and mechanical factors:

(i) Skin:

The skin is a very good barrier to infection as it has a horny outer layer, namely stratum corneum.

(ii) Mucous membrane:

The mucous membrane lining the various openings and passages of the body secrete mucous. It also acts as protective barrier to blocking of bacteria to epithelial cells.

(iii) Cilia:

The epithelial cells of the respiratory passage are lined with cilia. the micro-organisms trapped in the mucous.

(iv) Coughing and sneezing:

The mechanical actions such as coughing and sneezing help in drwing out the foreign particles that enter the digestive and respiratory tracts.

(v) Peristalsis:

The microorganisms that enter the intestine escaping various barrier, are pushed away by the peristaltic movement of the intestine, before they could invade and grow there.

(vi) Tear, saliva and urine:

The conjunctiva of the eye is freed of foreign particles by the flushing of the lacrimal secretion, namely tear.

The mouth is constantly bathed in saliva and the pathogens that enter the mouth are swallowed by the salivary secreation and digest in gut.

The washing action of urine eliminates microbial organisms from urethra.

(B) Biochemical factors:

(i) Secretion of the skin:

The secreation of salt in the sweat posses bactericidal activity. acidity of sweat low pH =5.5) has microbicidal effect. secreation through sebaceous and sweat glands:

(ii) Secreation of the digestive Tract:

The high acidity of (pH = 2.0) a microbicidal effect. the presence of HCl in gastric juice is secreated by Oxynetic cells.

(iii) Human milk:

Human milk is antibacterial substance, namely lactoferritin and neuraminic acid. they fight against E.coli and staphylococci.

(iv) Nasal secretion and saliva:

Secretions contain mucopolysaccharides which inactivate certain viruses.

(v) Lysozyme:

Tears, nasal secretions, saliva, polymorphonuclear leukocytes, human milk and most tissue fluids contain a mucolytic enzyme N-acetyl-muramidase, known as lysozyme.

(vi) Interferons (IFN):

Interferons are a group of soluble, non-toxic glycoproteins produced in small amount of all the cells in the body. this is an anti-viral agent which inhibits intracellular viral replication in cells infected with viruses.

Interferons are α-Interferon, β-Interferon and γ-Interferons.

(vii) complement:

The complement is complex system of enzymatic proteins found in serum and is activated by antigen-antibody complexes. they increases phagocytosis and destruction of MO.

(viii) Properdin:

It is a group of proteins present in serum and involved in resistance to infections.

(ix) Secretion of bacteria flora:

bacterial flora of skin produce various antimicrobial substances such as bacteriocins and acids.

(x) Semen:

It contains bactericidal components namely spermine and zinc.

(xi) Acute phase proteins:

this is group of plasma proteins which increase very rapidly during infection. one example of this group is C-reactive protein (CRP)

(c) cellular factors:

(i) Phagocytosis:

phagocytosis is a process of "cell eating" (erk-phagia - eating, cytosis - cell). they were discoverd by Metchnik-off (1838) they are two types, Semen: secretion of testis, consisting largely of sperms. Opsonin: substance present in plasma or other body fluids which by binding to cells or microorganisms increases susceptability to phagocytosis.

Promonocytes (in bone marrow)

↓

Monocytes (in blood)

↓

Macrophages

↓ ↓

Free Macrophages — Eg: Alveolar, peritoneal lymph other tissues are Free macrophages

Fixed macrophages — Eg: kupffer cells, osteoblasis, fixed macrophages of lymphoid tisue

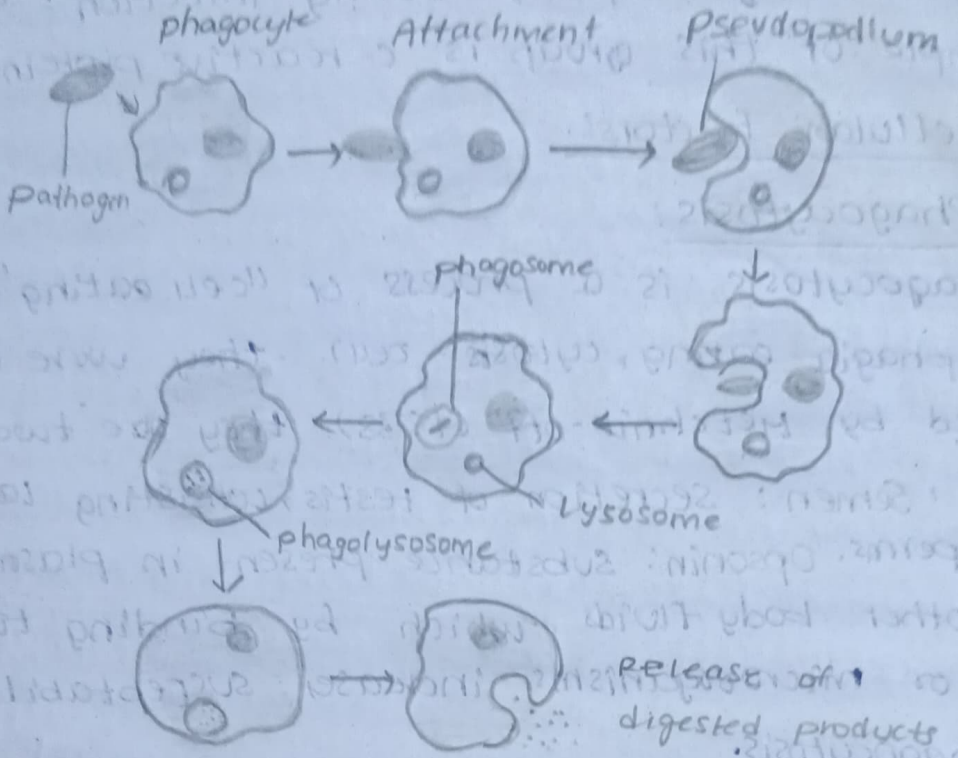
process of phagocytosis:

they include - chemotaxis, attachment, ingestion, intracellular killing - and digestion.

chemotaxis involves the movement of phagocyte to site of infection or inflammation in response to chemotactic factors produced

by the foreign particles (or) damged or dead tissues.

Different stages of phagocytosis.



(iii) Natural Killer cells (NK cells):

These are non-phagocytic lymphocytes having large granules. Hence these cells are also known as large granular lymphocytes. these cells show "natural cytotoxicity" and they can kill a range of tumor cells.

Functions:

1. Apoptosis - Killing of virus hidden inside the cell.
2. Lysis of virus infected cells.
3. Lysis of tumour cells.
4. Virus infected cell secrete cytokines.

(D) Genetic factor:

(i) Species immunity:

The resistance to a pathogen exhibited by all members of a species are example, rat are insusceptible to diphtheria while the guinea pig and human being are highly susceptible.

(ii) Racial immunity:

Within a species, different races may show difference in susceptibility to infection and is known as racial immunity.

(iii) Individual immunity:

They innate immunity show different individuals of the same race is known as individual immunity.

(E) Body:

(i) Temperature:

Temperature is also important in determing the innate immunity. For example - tubercle bacilli which are pathogenic to mammals (warm blooded animals) will not infect cold blooded animals.

(F) Inflammation:

Injury of tissues and irritation caused by entry of pathogens lead to cellular and vascular changes known as inflammation. the features are heat, pain, redness and swelling.

(G) Fever:

A rise in body temperature (pyrexia) following infection in a natural defense mechanism fever also stimulates the production of interferons and thus helps to recover from virus infection.

(2) Acquired Immunity (or) Adaptive immunity:

The resistance developed by man during his life is known as acquired immunity.

Acquired immunity is an adaptive against infections. It is not inherited from parents. But it is acquired in one's life time.

(A) Active immunity:

* Active acquired immunity is the resistance developped by an individual in response to an antigen entering the body either by natural infection or through vaccination
* Active immunity involves the synthesis of specific antibodies (humoral immunity) or production of immunologically active cells (cell mediated immunity).
* It is caused by infections or vaccines.

(1) Natural active immunity:

Resistance developed by the host after natural infections is called natural active immunity. A person attacked by measles or smallpox develops natural active immunity he recovers from diseases.

Example. life time immunity is got following certain viral infections such as smallpox, measles and mumps.

(2) Artificial active immunity:

The immunity developed by an organism in response to the vaccine is called artificial active immunity. vaccine are preparation of microorganism or their product.

Vaccines:

Vaccine are suspensions of microorganisms or their products to induce immunity in man against infectious microorganisms

they are three types of vaccines

(1) Live vaccines (Attenuated vaccines)

In this preparation, live microorganisms are attenuated by different methods. Attenuation" results in the loss of pathogenicity without the loss of antigenicity of microorganisms.

some vaccines are

(i) Anthrax vaccine: live bacilli causing anthrax are attenuated by growing at 42-43°c

(ii) BCG (Bacille calmette-Guerin): the bacilli are attenuated by cultivating in glycerol-bile-potato medium. Used for tuberculosis immunization

(iii) Sabin vaccine (oral poliomyelitis vaccine) It contains live attenuated strains of three types of poliomyelitis virus.

(iv) Measles vaccine: Attenuated measles virus vaccine is used for immunization children between 9 months to 10 years.

(2) killed vaccines

Microorganisms are killed in their virulent phase either by heat or antiseptics. while killing, care is taken not to denature the antigens by excessive heat (or) strong detergents. generally killed vaccines are less immunogenic when compared to live vaccines. they given by orally. in case of Taboral (TAB)

(i) Salk vaccine

(ii) Influenza Virus vaccine

(iii) TAB vaccine

(iv) Pertussis vaccine.

(1) Live vaccines (Attenuated vaccines)

In this preparation, live microorganisms are attenuated by different methods. Attenuation" results in the loss of pathogenicity without the loss of antigenicity of microorganisms.

Some vaccines are

(i) Anthrax vaccine: live bacilli causing anthrax are attenuated by growing at 42-43°c

(ii) BCG (Bacille Calmette-Guerin): the bacilli are attenuated by cultivating in glycerol-bile-potato medium. Used for tuberculosis immunization

(iii) Sabin vaccine (oral poliomyelitis vaccine) It contains live attenuated strains of three types of poliomyelitis virus.

(iv) Measles vaccine: Attenuated measles virus vaccine is used for immunization children between 9 months to 10 years.

(2) Killed vaccines

Microorganisms are killed in their virulent phase either by heat or antiseptics. while killing, care is taken not to denature the antigens by excessive heat (or) strong detergents. generally killed vaccines are less immunogenic when compared to live vaccines. they given by orally. in case of Taboral (TAB)

(i) Salk vaccine
(ii) Influenza Virus vaccine
(iii) TAB vaccine
(iv) Pertussis vaccine.

(3) Toxoid vaccines:

Toxoids are preparations of toxins (products of microorganisms) inactivated by formalin they retain the antigenic potency and thus like toxins, can induce antitoxin formation.

(i) Tetanus toxid: Formaldehyde detoxicated tetanus toxin of tetanus bacteria is used in prophylactic immunization against tetanus.

(ii) Diphtheria toxoid: toxoid prepared by formalin treatment of the bacterial toxin producing diphtheria.

(iii) Triple vaccine (DPT) A mixed vaccine containing diphtheria toxoid, tetanus toxoid and pertussis vaccine

(B) Passive immunity:

The resistance developed by a non-immune individual by receiving antibodies or sensitized lymphocytes from an immune individual is known as passive immunity.

The antibodies or sensitized cells are transferred from immunized host to a non-immunized host.

(i) Natural passive immunity:

The development of resistance in foetus by the transfer of antibodies from the mother to the foetus naturally is known as natural passive immunity.

In human beings, natural passive immunity occurs mainly by passage of antibodies from mother to her unborn child through the placenta during the later part of pregnancy

the antibodies crossing the placenta are entirely IgG. Other immunoglobulin sub types A, D, E and M do not cross the placental barrier.

In other primates and in most of the other mammals such as pig, the transfer of antibodies from the mother to young one occurs mainly orally through colostrum.

Human colostrum offers protection to the newborn as it rich in IgA antibodies.

(2) Artificial passive immunity:

The development of resistance in a patient by transferring antibodies or immunized lymphocytes from a donar is known as artificial immunity.

Artificial passive immunity is therapeutically used in the treatment of tetanus, diphtheria, gas gangrene, snake bite and immunodeficiency diseases.

(i) Hyperimmune serum of animal (or) human origin: The serum prepared from immunized man or animal by injecting an antigen is called hyperimmune serum.

(ii) Convalescent serum: Serum collected from persons recovering from a particular infectious disease contains high amount of antibodies for the specific antigen causing that particular diseases, against viral infections such as measles and rubella.

(iii) Pooled sera from different healthy individuals: Sera of healthy adults contain antibodies against the infectious microorganisms commonly prevalent in that community.

(iv) Combined immunization: A combination of both active and passive methods of immunization employed simultaneously is known as "combined immunization", used in emergency cases.

(v) Adoptive immunity: This is a type of passive immunity produced by injecting immunologically competent lymphocytes - this method is adopted in the treatment of tuberculosis and leprosy.

Lymphoid organs:

The organs concerned with the production of immune cells and immune reaction are called lymphoid organs.

They contain lymphoid cells (lymphocytes)

The lymphoid organs are the production and training centre of lymphocytes.

→ they are two types of lymphoid organs system

(1) Primary lymphoid organs: (central)

Primary lymphoid organs are the major sites of lymphopoiesis. the lymphoid stem cells proliferate, differentiate and mature into immunocompetent cells in the absence of antigenic stimulation.

The primary lymphoid organs are large at birth and they atrophy with age.

they are

(i) Thymus

(ii) Bursa of fabricius in birds

(iii) Bone marrow in mammals

(1) Thymus :

* Thymus is a primary lymphoid organ where develop T cells.
* Thymus is the training centre for the T-lymphocytes. (matures of T cells)
* It begins development on 6th week of gestation.
* At the time of birth, it weighs about 15 to 20gms and increases to about 40gms in weight by puberty.
* In human beings, the thymus consists of two oval lobes just behind the top of the sternum, below the thyroid gland.
* The lymphocytes multiply rapidly and from thymic lymphocytes (T-Lymphocytes) which cause the cell mediated immunity.

(ii) Bursa of fabricius:

* Bursa of fabricius is a primary lymphoid organ in birds.
* Bursa is the training centre for the army of B lymphocytes
* In birds B cells develop from the stem

cells present in the yolksac, liver and bone marrow.
* Primordial B cells migrate to the bursa and mature into B cells.
* Bursa is a sac-like lymphoepithelial structure
* It is attached to dorsal side of cloaca.
* It is formed of many lobes called follicles.
* Each follicle has an outer cortex and an inner medulla.
* Bursa is responsible for
  - Maturation of B lymphocytes
  - Humoral immunity.

Functions:
1. B Lymphocytes mature in the bursa.
2. It brings about humoral immunity.

(iii) Bone Marrow:

* Bone marrow is the soft tissue located within the bone.
* It is the army heard quarter of the immune system.
* It has a total weight of about 3kg in an average human adult.
* There are three types of bone marrow tissues, namely;
1. Red marrow
2. Yellow marrow
3. Stroma

(1) Red Marrow:

* Red marrow is called medulla ossium rubra. it consists of mainly haematopoietic tissue. RBC, WBC and platelets arise from red marrow.
* Red marrow is found mainly in the flat bones such as pelvis, sternum, cranium, ribs, vertebrae, scapulae and in the epiphyseal ends of long bones like femur and humerus.
* The red bone marrow contains blood vessels and capillaries.
* At birth all bone marrow are red. with increasing age red marrow is converted into yellow marrow.

(2) Yellow Marrow:

* yellow marrow is called medulla ossium flava. it is mainly made up of fat cells.
* yellow marrow is found in the interior of long bones.
* The yellow marrow contains blood vessels and capillaries.
* In case of serve blood loss, the body can convert yellow marrow back to red marrow to increase blood cell production.

(3) Stroma:

* Stroma is the tissue of bone marrow that is not directly involved in haematopolesis.
* Yellow bone marrow makeup the majority of stroma. some red marrow cells also const

itute stroma.

* The following cells constitute stroma.

- Fibroblasts - Reticular connective tissue.
- Macrophages.
- Adipocytes
- Osteoblasts
- Osteoclasts
- Endothelial cells
- Mesenchymal stem cells.

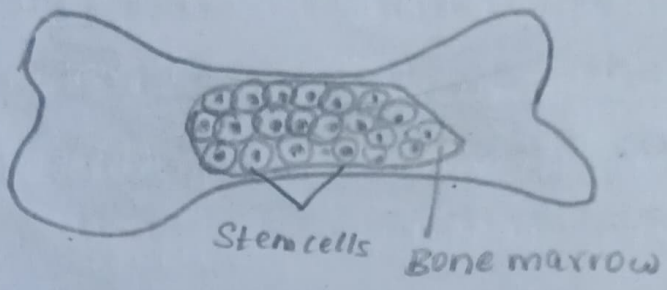
* The stroma is indirectly involved in haematopoiesis.

* It provides a haematopoietic micro environment.

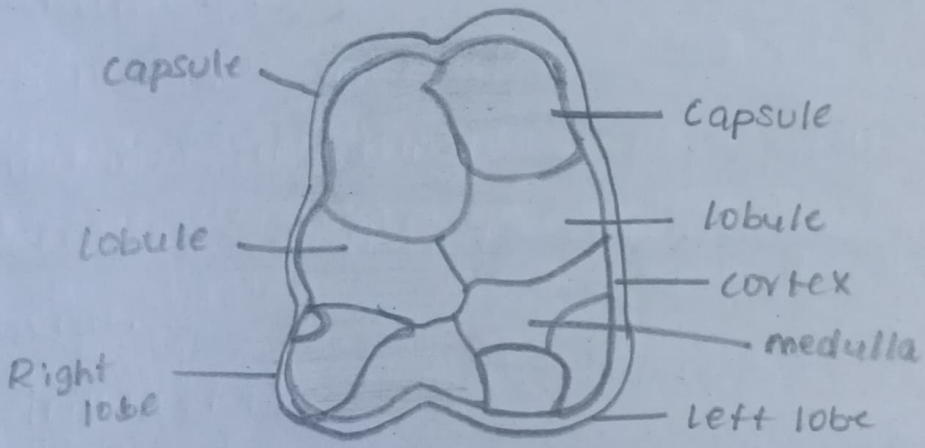
* It generates colony stimulating factors for haematopoiesis.

* It provides iron for RBC.

Bone Marrow



Thymus



T.S of thymus

Bursa of Fabricius of a chicken.