LESSON – 3

IMMUNOLOGY

(Bio – Zoology)

Marks

1x1 = 1

2x3 = 6

1x5 = 5

12

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CHAPTER – III

IMMUNOLOGY

1. Immune System:-

The system of animal body, which protects it from various infections, agents and cancer.

2. Immunology:-

A study of the immune system.

3. Immunis means **"exempt"** or **freedom gave rise to immunity**

4. Immunity:-

All the mechanism used by the body for protection from environmental agents that are foreign to the body (or) Disease resistance exhibited by the host towards microorganism or its products.

5. Agents:-

Microorganism (Bacteria, Virus, Protozoa, Fungi) or their products (Exotoxin, Endotoxin, Enterotoxins) certain food items, chemicals, drugs (Penicillin) and pollen grains (Parthenium)

By

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5 mark

Types of Immunity

I. Innate (Non – Specific) Immunity 3 mark

It comprises all those natural defence mechanism with which an organism is protected from infection.

- First Line Defence in many (most) animals
- The Pathogens that enter into the body are quickly killed by some components of the immune system.

II. Acquired Immunity (Specific Immunity) 3 mark.

It is a specific immunity, capable of recognizing and selectively eliminating Specific microorganisms

- Found only in vertebrates.
- Supplements natural immunity
- It require several days to be activated. It is due to the failure of innate immunity.) 5 mark.

Barriers of Innate Immunity:

Barriers that prevent entry of foreign agents into the body. Barriers are four types namely **Anatomical, Physiological, Phagocytic** and **inflammatory.**

3

I. ANATOMICAL BARRIERS

- Skin, mucous members lining the respiratory, intestinal and reproductive passages constitute the anatomical barriers.
- Mucous membrane entraps foreign microorganisams
- Cliliary movements produced by the epithelial lining cells expel out microorganisms.) 3

II. PHYSIOLOGICAL BARRIERS:

i. Body temperature, PH and various body secretions are examples for physiological barriers.
ii. Fever response inhibits growth of many organisams.
iii. Acidic nature of stomach (gastric juice) due to HCl secretion (oxyntic cells) kills ingested microorganisms. (1)
iv. Tears and Saliva contain Lysozyme, digest baterial cellwalls.
v. Cells like WBC release Interferons (antiviral protein) when infected with a virus. Interferons make the cells resistant to viral infections) 3.

III. PHAGOCYTIC BARIERS

i. It is the important mechanism of innate immunity, performed by leucocytes.
ii. The total count of leucocytes increased in response to pathogenic infections.
iii. Macrophages and Neutrophils are the most important phagocytes.
iv. In response to an infection, monocytes are liberated at the site of infection and get converted into macrophages.
v. Macrophages engulf microbes, viruses and cellular debris
vi. M.P and neutrophils contain bacterilytic enzymes and free redicals, which destroy the pathogens.

IV. INFLAMMATORY BARRIERS

i. Inflammatory Barriers: An infection or tissue injury results in redness, swelling, pain and production of heat, results in fever. This is known as inflammatory response.
ii. It is due to release of chemical alarm signals namely **histamine, serotonin** and **prostoglandins** by the damaged **mast cells.**
iii. Leakages of vascular fluid at the site of inflamation. The **serum proteins** in the fluid are antibacterial in nature.
iv. Influx of phagocytic cells into the affected area takes place.
All these responses inhibit and destroy the microorganisms.

V. NATURAL KILLER CELLS (T LYMPHOCYTES)

i. Kills virus infected and some tumour cells of the body.
ii. NK cells create **perforin** – lined pores in the plasma membrane of the **target cells** (Microorganisms)
iii. Entry of water takes place through the pores into the target cells. Target cells then swells and bursts.

ACQUIRED IMMUNITY

UNIQUE FEATURES

i. **Specificity:** Ability to distinguish differences among various foreign molecules
ii. **Diversity:** Recognize a vast variety of foreign molecule
iv. **Discrimination between Self and Non-self:**
a)Recognize and respond to foreign molecules
b)Avoid response to these molecules that are present within the body (self –antigen)
v. **Memory**
a. When the immune systems encounters a specific antigen (foreign agent), for the first time, it generates an immune response. The invader is eliminated
b. It retains the memory for a prolonged period
c. If a second encounter with the same antigen evokes a increased immune response.

etc: Give short note on macrophages.
(i) In response to an infection, monocytes are liberated at the site of infection and get converted into macrophages.
(ii) Macrophages engulf microbes, viruses and cellular debris.
(iii) Bacteriolytic enzymes and free radicals of these cells destroy Pathogens.

EMPLOYERS OF SPECIFIC IMMUNITY

Lymphocytes, Antigen presenting cells are the employers of specific immunity.

A. Lymphocytes

i. Produced in bone marrow.
ii. The process of production of lymphocytes is called **haemtopoiesis.**
iii. Trillions of lymphocytes are present in a healthy individual .
iv. Types:
   a. T lymphocytes (Tcells)
   b. B lymphocytes(Bcells)
v. Some Immature lymphocytes migrate to the thymus, mature and differentiate as T.cells (T lymphocytes)
vi. Maturity of Bcells takes place in the bone marrow.
vii. B and T cells generate two types of specific immunity namely
   a. Cell mediated and
   b. Antibody - mediated/humoral immunity.

Types of Adaptive/Acquired Immunity

I. **Active immunity:** It is due to the immune response generated in the individual in a question by a **pathogen** or **vaccine**(due to antigenic stimulus)
II. **Passive immunity:** Transfer of immune products (antibodies) from an individual into a non-immune individual (Taking antibodies in a ready made form)

Activation of Adaptive immunity

i. Antigens are processed by antigen presenting cells (APC) eg: Macrophages, B lymphocytes and dentric cells
ii. After processing antigens are presented on the surface of APC.
iii. T helper cells (sub group of T cells) specifically interacts with the antigen and becomes activated.
iv. Activated T helper cells then activate B cells and cytotaxic lymphocytes (CTLS-subgroup of T cells)
v. Activated B, CTLS proliferate and produce clones.
vi. Cloned cells can recognize the same antigen and eliminate it.

Types of specific immunity

I. Cell –mediated immunity (CMI)
   i. It is the responsibility of cytotoxic lymphocytes or CTLs (sub group of T cells)
   ii. An activated CTLs is target specific, infect and kill the target cell by variety of mechanisms.
   iii. CTLs prevents the target cell growth and completion of life cycle of the target cell (pathogen)
   iv. CMI is also involved in killing of cancer cells.

II. **Antibody mediated immunity or Humoral immunity:** 3 marks.

i. It involves the synthesis of specific antibody molecules – Immunoglobulins by Btype lymphocytes.
ii. Each antigen matches a specific antibody and binds to it (due to antigenic determinants)
iii. Antibody –mediated immunity directed by B-cells.
iv. Igs (antibody molecule) may be bound to a cell membrane in the form of receptors or they may remain free.)5

Functions of free antibody 3m x 1

i. Agglutination of particulate matter (bacteria, virus/antigen) including and . x.
ii. Neutralization of toxins (released by bacteria) . 3marks.
iii. Opsonisation/coating –over bacteria to faciliatate recognition and phagocytosis (by phagocytes) x.

)3m x 1

LYMPHOIDAL ORGANS

5 Structure and functions of the immune system

i. The L.S consists of lymphoid cells and lymphoid organs
ii. Lymphocytes and plasma cells are examples for lymphoid cells
iii. Lymphoid organs are classified into two types namely central (primary) and peripheral (secondary)
iv. **Central lymphoid organs:**
   a. The bone marrow, thymus (mammals) and bursa of fabricus in birds represent central lymphoid organs
   b. Primary lymphoid organs are lymphoepithelial structures 3.
   c. Here the precursor lymphocytes proliferate, develop and acquire immunological capability. Finally they accumulate blood and lymph.
v. **Peripheral lymphoid organs:-**
   Example: The spleen, lymph node, Mucosa associated lymphoid tissue (MALT) 3
vi. **Other immune systems**
   Payer's patches (lymphoid tissue in gut).
   Appendix, tonsils, salivay, tear glands and secretions of the lactating breast of the mother. 3)5

THYMUS

I. **Development:**

i. It develop at about the sixth week of gestation 1
ii. Mesenchymal stem cells from the yolksac fetal liver, and bone marrow reach the thymus and differentiate into the thymocytes (Thymic lymphoid cells)
iii. Mesenchymal stem cells are the precursors of lymphocytes. 1
iv. Thymus acquires its lymphoid appearance by the third month of gestation.
v. Thymus is the first organ in animals to become predominantly lymphoid.
vi. Thymus reaches its maximal size just before birth.
vii. After puberty, it undergoes spontaneous Progressive involution.)3

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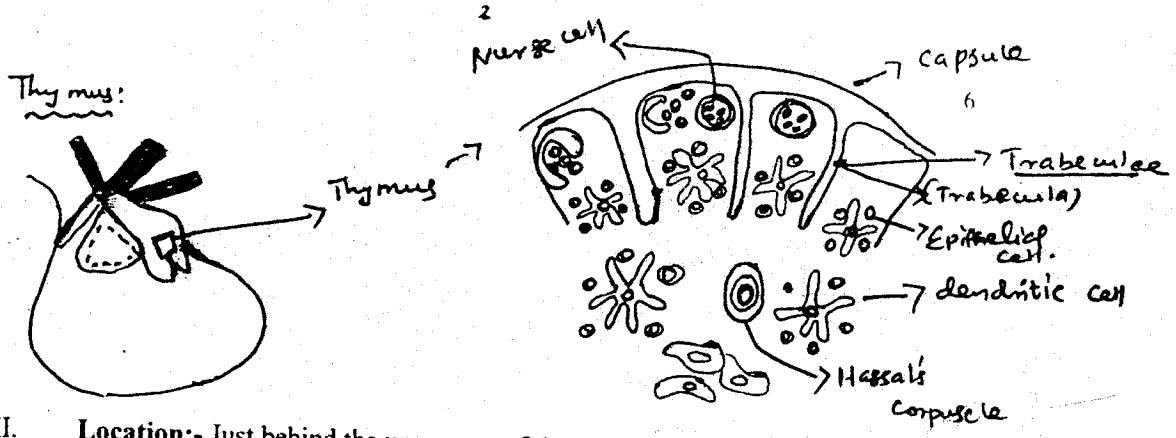


II. **Location:-** Just behind the upper part of the heart (anterior to heart)

III. **Structure:** Diagram refer book.

i. Thymus has two lobes surrounded by a fibrous capsule.

ii. Septa arise from the capsule divide the gland into lobules.

iii. The lobules are differentiated into outer cortex and inter medulla.

iv. Cortex contain proliferating small lymphocytes. Medulla consists of epithelial cells, mature lymphocytes, Hassall's corpuscles (Aggregation of epithelial cells)

IV. **Functions of Thymus:**

i. Production of thymic lymphocytes (T cells)

ii. Thymus is the major site for T lymphocyte proliferation in the body.

iii. Of the lymphocytes produced in the Thymus only about one percent leave the thymus. The rest are destroyed by apoptosis (Programmed cell death)

iv. The lymphocytes acquires new surface antigens (Thy antigens) in the Thymus.

v. The function of Thymus independent of antigenic stimulation.

vi. Thymus confers immunological competence on the lymphocytes (except prethymic lymphocytes).

vii. Lymphocytes are educated by the thymus so lymphocytes are capable of mounting cell mediated immune response against appropriate antigens.

viii. **Thymulin, Thymosin** and **Thymopoietin** are the hormone like factors produced by the Thymus.

ix. The importance of thymus in lymphocytes proliferation and development of CMI is evident from the effects of lymphopaenia and neonatally thymectomised mice.

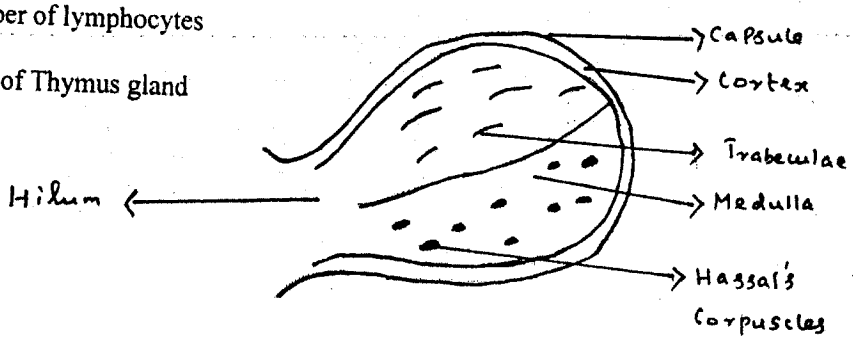
x. **Location of T lympocytes**
Peripheral lymphatic tissue, white pulp of the spleen, around the periarteriole region and in the para cortical areas of lymph nodes.

LYMPHOPHENIA:-

Decrease in number of lymphocytes

Thymectomy:-

Surgical removal of Thymus gland

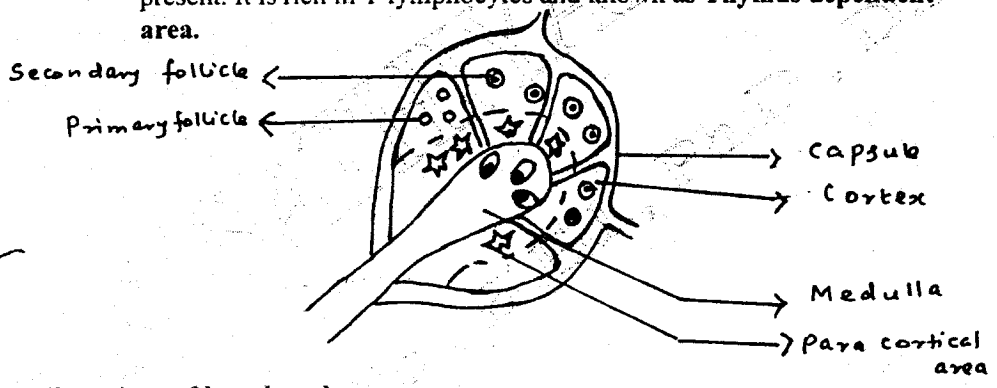


Peripheral Lymphoidal Organs

Lymph nodes:

1. **Location:** Small round or ovoid bodies placed along the course of lymphatic vessels.
2. Lymph nodes are surrounded by the fibrous capsule from which trabeculae penetration into the nodes.

a) **Structure** Lymphnode is differentiated into outer cortex and inner medulla
b) **Cortex:** It is nothing but accumulation of lymphocytes (primary follicles). Germinal centers during antigenic stimulus. The follicle also contain dendritic macrophages which capture and process the antigen.
c) **Medulla:** Here the lymphocytes are arranged as medullary cords (branching bands)
d) The cortical granules and medullay cords contain B lymphocytes and known as **bursa** or **bone marrow dependent areas.**
e) Between cortical granules and medullary cords, paracortical areas is present. It is rich in T lymphocytes and known as **Thymus dependent area.**



4. Functions of lymph nodes

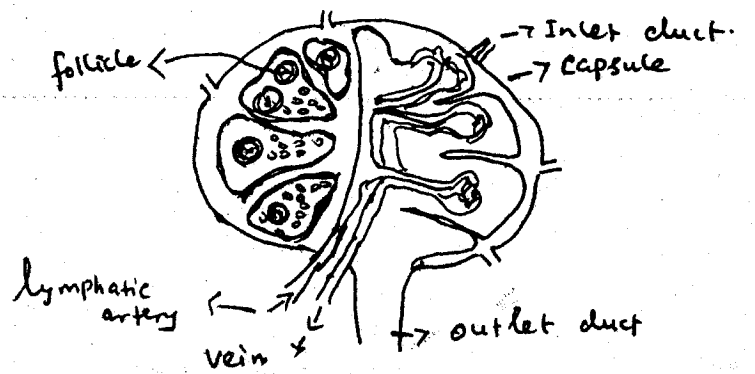
a. Act as a filter of lymph.
b. Phagocytose foreign materials including microorganisms,
c. Help in the proliferation and circulation of T and B cells.
d. They enlarge following local antigenic stimulation.

5. Totally about 600 lymph nodes are distributed in the human body.

Spleen

Functions of spleen:

a. Largest lymphoid organ .
b. It monitor abnormal erythrocytes and destroy them (**graveyard for RBC**)
c. Acts as a reserve tank and setting bed for blood.
d. It acts as a systemic filter for trapping circulating blood borne particles.
e. Spleen contains red and white pulp regions that serve as filter.
f. The macrophages within the spleen help to remove and destroy pathogens.



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MUCOSA ASSOCIATED LYMPHOID TISSUE (MALT)

3

1. Mucosa is the lining layer of the aliementary canal, respiratory genitourinary and other lumina.
2. These Mucosa areas are constantly exposed to numerous antigens.
3. These areas contain rich collection of lymphoidal cells eg:- patches specialized aggregates or scattered lymphoid follicle called as MALT.) 3
4. Lymphoidal tissue in the gut is called GALT (gut associated lymphoidal tissue)
5. Lymphoid tissue in the respiratory tract is called BALT (Bronches Associated Lymphoidal Tissue)
6. MALT contain lymphoid cells and phagocytic cells) 3
7. The mucosa is also endowed with secretory Ig A. (1)
8. The mucosa regions confer protection from enteric and respiratory infections.) 5.

ANTIGENS

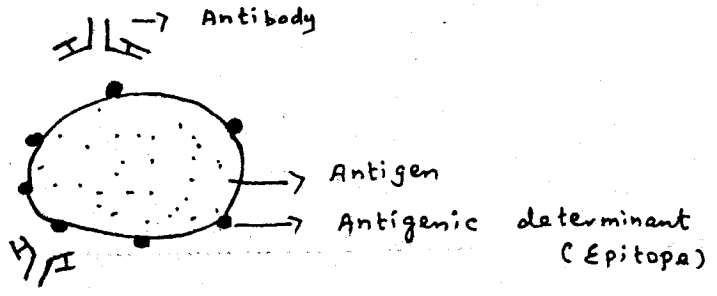
1. **Immunogen:** A molecule that provoke an immune response (Immunogenicity) or Antigenic substances which elicit both humoral or cell mediated response is defined as immunogen. 3 mark
2. **Antigen:** A molecule which reacts with the anitbody produced or with the activated cellular constituents of CMI (antigenicity)

Or

Generally the substance, which are capable of eliciting as immune response. that is, the synthesis of antibodies are called antigens.) 3

3. **Hapten:**
   a. Haptens are small well defined chemical groups (dinitrphenol-DNP) which are not immunogenic on their own but will react with performed antibodies.
   b. To make a hapten immunogenic, it must be linked to a carrier molecule which is itself immunogenic.) 3.

4. Antigens are recognized by antibodies and antigen speicific T cell receptors.
5. Immunoglobulines recognize intact antigens but T cell, surface receptors recognize processed antigen presenting cells.



* etc: * Comment on L chain of Immunoglobulin.

(a) The smaller chains of immunoglobulins are called light (L) chains.
(b) L-chain has a molecular weight of approximately 25000 daltons.
(c) L-chain attached to the H-chain by a disulphide bond.
(d) L-chain occur in two varieties Kappa (κ) and Lamdha (λ)

3 marks

6. **ANTIGENIC DETERMINANTS AND EPITOPES:**
   a. **Parotope:** The part of the antibody molecule which makes contact with the antigen.
   b. **Epitope:** The part of the antigen molecule that makes contact with the partope) 3 marks
   c. Most antigens are protein in nature, three dimensional tertiary structure.
   d. There may be cluster of aminoacids sequences on the three dimensional structure constituting a series of epitopes.
   e. Each of these epitope clusters is meant by an antigenic determinant.

7. **TYPES OF ANTIGENS**: eg. Natural, Aritifical (synthetic), potential
   a. **Natural:** It is of two types namely particulate and soluble antigens.
      i. **Particulate:** Bacteria, Viruses, erythocytes and cells.
      ii. **Soluble:** Bacteria toxiens, proteins, erythocytes, carbothydrates, glyco proteins and lipoproteins.
   b. **Potential antigens:** A variety of chemical compounds Biological macromolecules, synthetic polypeptides.
   c. Several polysaccharides, nucleoproteins and lipoproteins are also considered as antigens.
   d. Recently antibodies to DNA have been used in immunization.) 3

5 (**ANTIBODIES:- IMMUNOGLOBULINS**

1. Humoral basis of immunity
   The introduction of an antigen into an animal, certain substances called antibodies appeared in the serum and tissue fluids. They reacted with the antigen specifically and in some observable manner.
2. Depending upon the observable reactions antibodies are classified into **agglutinins, precipitins** etc.,
3. **Immune sera/antisera:** Sera having high antibody levels due to infections/immunization)3
4. **Immunoglobutins (Igs)** (Draw the book diagram-)
   a. They are glycoproteins.
   b. Each molecule consists of two pairs of polypeptide chains, namely smaller chains (L or Light chains) and larger chains (heavy or H)
   c. The molecular weight of L chain-25,000 and H-chain 50,000 doltans.
   d. L chain attached with the H chain by a disulphide bond. The two H chains are united/held together by 1-5 disulphide bonds (S-S)
   e. **Classification:** IgG (gammer) IgA (alpha-α) IgM(μ), IgD(Delta) and IgE (epsilon) (3)
   f. The L chains are similar in all classes of immunoglobulins but H chains structurally and antigentically distine for each class.
   g. L- chains in two varieties namely Kappa(κ) and lambda(λ)
   h. Immunoglobulin molecule may have either κ or λ chains, but never both.

Regions of Polypeptide chains

I. The variable region (v) or Fab region (Fragment antigen binding site)
   i. It shows a wide variation in amino acid sequences in the amino or N-terminal portion of the molecule.
   ii. These areas are also known as **"hotspots" hypervariable** regions due to high variability in the H and L chains.

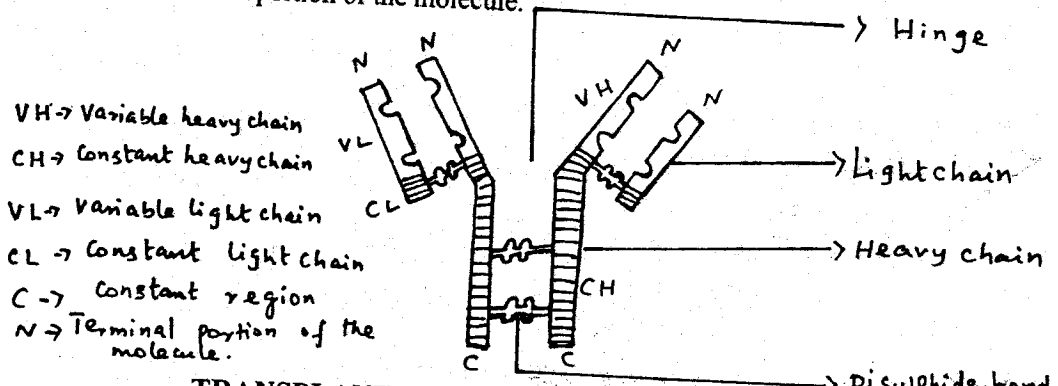
iii. Hot spots involved in the information of the antigen binding site. 10

iv. Atleast three hypervariable regions/hotspots present in both VH and VL regions of the chain.

v. Antibody specificity of immunoglobulins depends on the variability of aminocid sequences at thehotspot (H, L- regions). And finally it form the antigen combining sites (paratope)

II. Constant (C) region/Fc region:

It denotes constant region with unvarying aminoacid sequence in the C or COOH terminal portion of the molecule.



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TRANSPLANTATION IMMUNOLOGY

(3 1. **Transplantation:** The replacement of a diseased organ by a transplant (healthy tissue/organs)) mention the types too.

2. **Nature of graft** (transplant) rejection first explained by Medawar(1940) while working with the patients of world war – II. ①

3. **Observations of Medawar:**

a. graft of skin from one region of the body to another in the same patient was easily accepted

b. Grafts obtained from close relatives like brothers or sister were rejected.

② c. When a second graft was performed, by obtaining the tissue from the same donar, the rejection reaction occurred with great intensity and speed.

d. The graft (transplant) leads to various complication in the host body, and it is mediated by the host's immune response.

e. Graft rejection lead to graft verses host reaction/diseases.

(5 4. **Classification of grafts:**

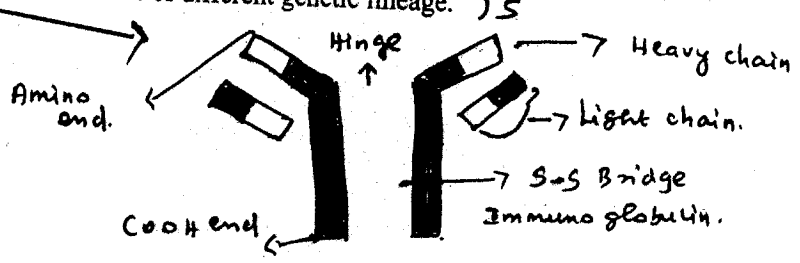
a. **Autograft:** The tissue of the original donar is grafted back into the same donar. Eg. Skin graft from thigh to face of burnt individual (plastic surgery)

b. **Isograft**: Graft between syngeneic individuals Eg. Clones or identical twins

c. **Allo (or) homograft:** Graft between allogenic individuals Eg. Kidney transplanted from one human to another members of same species but of different genetic constitution.

d. **Xenograft/Hetrograft:** Graft between xenoghenic individuals Eg. Organ transplanted from pig to human baboon to human (Xenogenic)- members of different genetic lineage.)5

Draw this book diagram



Process of graft rejection (Allograft)

1. Graft rejection occurs when the graft or tissue involves two genetically distinct members of the same species. It is because the antigen of the graft and the host being different, the immune response of the host rejects the graft.
2. **Symptoms of graft rejection:**
   a) Skin rashes
   b) Fluid accumulation in spleen and enlargement (Splenomegaly)
   c) Emaciation (becoming thin)
   d) Anaemia and immune suppression
   e) Increased bilirubin synthesis.
3. **Cell mediated and humoral immune responses:**
   a. Sensitized T cell (lymphocytes), macrophages, and plasma cells involved in the primary or first set rejection.
   b. B cells (B.lymphocytes) and their antibodies involved in secondary or second set rejections.
   c. In the cell mediated reactions interleukin-1(IL-1), interleukin-2(IL-2)etc take part.
   d. Lysis of graft is achieved by lymphotoxins or tumour necrosis factors (TNF) or proteolytic enzymes.

Prevention of graft rejection (clinical fields)

a. Blood group estimation in the host (ABO and Rh)
b. Testing the presence of cytotoxic antibodies in the host serum.
c. Cross matching of tissues prior to transplantation (Host V Graft)
d. Total lymphoid tissue irradiation.
e. Giving immuno & suppressive drugs like **cyclosporin** and **steroids** etc.

Genetic basis of organ transplants

1. Success of organ transplants depends on a proper matching of histocompatability antigen that occur in all cells of the body.
2. **Histocompatability:-** The compatability between donar and recipient tissues in transplants.
   e.g : (a) Major histicompatability complex -> MHC cluster of genes occur in chromosome number – 6 of mouse.
   (b) Human lencocyte antigen complex -> HLA
3. In man the alleles of HLA genes determine the histocompatability.
4. **Haplotype:-** The array or cluster of HLA alleles on a homologue of our chromosome – 6.
5. An individual inherits one HLA haplotype from each parent.
6. Only identical twins have the identical haplotype.

CYCLOSPORIN:- An agent obtained from soil fungus used to suppress the rejection of allografs.

Immune System Disorders:

1. It is a multicomponent interactive system. It effectively protects the host from various infections.
2. Improper functioning of the immune system can cause discomfort, diseases and even death.
3. **Classification of improper functions:**
   a. Hypersensitivity or allergy
   b. Auto – immune diseases
   c. Immunodeficiency
4. **Hypersensitivity or allergy:**
   a. Allergies results from an inappropriate and excessive immune response to common antigens.
   b. Allergens: The substances that causes allergies.
   c. Common allergens: Dust, Mould, certain foods, some medicines (eg. Penicillin)
   d. Allergy involves mainly IgE antibodies and histamine. Histamine secreted by mast cells.
   e. Common manifestation of allergy is asthma
   f. **Anaphylaxis:** A sudden, violent and fatal reaction in a sensitive individual due to allergen. / Sometimes an allergen may cause a sudden violent and fatal reation in a sensitive individual is called anaphylaxis.)
5. **Autoimmune diseases:**
   a. It takes place when the immune system attacks and destroy self cells and molecules.
   b. It can cause chronic and serious diseases.
   c. Examples: Insulin-dependent disabetes, rheumatoid arthritis and multiple sclerosis.
   d. Multiple sclerosis caused by antibodies that attack the myelin sheath of nerve cells.
6. **Immuno deficiency diseases:**
   1. These diseases results from a defect in one or more components of the innate or adaptive immunity.
   2. Affected individulas are susceptible to diseases.
   3. Immunodeficiency diseases due to: gene mutations, infections, malmutrition or accidents.
   4. **Types:** A. serve combined immunodeficiency (SCID) B. AIDS
   5. **Serve Combined immunodeficiency (SCID)**
      a. It result from one of many genetic defects
      b. One genetic defect leads to adenosine deaminase deficiency
      c. **Symptoms:**
         i. Very low number of circulating thymocytes
         ii. Affected individual usually die at an early age.

6. AIDS: (5)

a. Causing Agent: Retovirus (HIV)
b. RNA is the genetic material in HIV
c. HIV infect and kills T- helper cells
d. The depletion of T-helper cells weakens the acquired immune responses
e. The viral RNA is converted into DNA copy by reverse transcryptase enzyme.
f. The HIV-DNA copy inserted into the human chromosome and replicates with cell DNA.
g. It may be transcribed to produce RNA copies of viral genome.
h. RNA copies are packaged and liberated as virus particle.
i. Lysis of infected cells takes place.
j. The released virus particle infect new T-helper cells.) 5

Multiple Sclerosis:- (3)

i) It is neurological disease characterized by progressive degeneration of the myelin sheaths of neurons in multiple areas of CNS.
ii) Normal conduction of impulses are affected.
iii) Action potential initiation affected.

ALL THE BEST!

Immunology

16/05 1) Barriers of natural immunity
17/05 2) Unique features of acquired immunity
18/ Activation of adaptive immunity
19/ Lympoidal organs
20/ Functions of Thymus gland
21/ Lkymp node
22) Mucosa associated lymphydal tissue