

Unit 5- Specific defence mechanism in Fish

Specific defence mechanism in Fish

Specific immune system can be seen in vertebrates which is also referred as advance defence system in organisms.

Specific immune system are made up of two cellular systems:

- Humoral antibody system (B cells)
- cell-mediated immunity (T cells)

Humoral Antibody System (B cells)

Humoral antibody uses B cells where the B cells differentiate into antibody producing Plasma cells and Memory cells. Series that involved in stimulating B cells to produce antibody are:-

Antigen presentation

The antigen-presenting macrophages recognize the pathogen (e.g., virus) engulf the pathogen, digests it and displays antigen on their surface. The processing involves proteolysis, which presumably occurs within acidic subcellular compartments. These macrophages display residual foreign antigen on the cell membrane and this is 10 times more effective than unbound antigen in promoting immune response.

On the other hand, other viral particles infect nearby host cells.

The macrophages also secrete a protein called interleukin- 1 (IL- 1) which activates the helper-T cells. Besides macrophage, the B cell also acts as antigen presenting cell due to its antigen-binding receptor.

Helper T cells

These T cells are activated when macrophages-bound antigen linked to class II Major Histocompatibility Complex (MHC) in the presence of interleukin-1 and they secrete two factors like B cell growth factor (IL-4) and B cell differentiating factor (IL-5). The IL- 1, IL-4 and IL-5 act together to provoke B cell to respond quickly.

B cell activation

If B cell immunoglobulin receptor molecules are crosslinked by foreign antigen and its IL-1 and IL-4 receptors are stimulated, the B cells are activated and express new class II MHC antigen. The membrane receptors for antigen are concentrated at a particular position on the surface of the B cells. The B cells divide repeatedly to form antibody-secreting plasma cells and memory cells. These plasma cells are widely distributed throughout the body but concentrated in the head kidney and spleen of fish. The plasma cells usually die after 3-6 days of secretion and the immunoglobulin levels in the serum decline gradually. The second populations of cells derived from antigen- sensitive B cells and morphologically indistinguishable from parent cells are known as memory cells.

Cell-Mediated Immunity (T cells)

Antigenic fragments present on the macrophage alert a specific type of T lymphocyte ("helper" T) about the attack of intruder. These helper T cells recognizes antigen particles

and binds to the macrophage via an antigen receptor. Helper T cells are unique to a specific antigen.

This binding stimulates production of chemical substances such as interleukin-1 (IL-1), tumor necrosis factor (TNF) by macrophage

Helper T cells generate interleukin-2 and gamma interferon (IFN- γ)

All substances facilitate intercellular communication.

Lymphoid organs in fish

There are two types of lymphoid organs that can be seen in fish. Primary lymphoid organs include thymus and head kidney that produce and mature stem cells. The secondary lymphoid organs include kidney, spleen, and Mucosa lymphoid tissue. Besides, liver, skin, intestine and heart are also important organs that take part in the defence. The endothelial cells and macrophages present in these organs are highly endocytic towards 'self' or 'non-self' substances. The development of lymphoid organs does not necessarily correspond to the maturation of immune functions. Even though the organs develop simultaneously in trout and salmon, the surface IgM positive cells appear 8 days pre-hatching in trout and 45 days post-hatch in salmon.

Primary lymphoid organs

Primary lymphoid organs mainly contain thymus and anterior kidney.

Thymus

It is situated in the dorsolateral region of the gill chamber close to the opercular cavity.

Thymus is the primary lymphoid organ and mostly contains T cells and few populations of B cells. The thymus starts developing from 24 hours after fertilization and it is the first lymphoid tissue to become populated by lymphocytes during development. Once developed the thymocytes migrate from thymus to spleen and kidney. Along with sIg⁻ and sIg⁺ lymphocytes thymus also possesses epithelial cells, monocytes, macrophages, neuroendocrine cells etc.

Anterior kidney

The anatomy of the kidney varies from species to species. The kidney of teleost fish not only functions as the excretory organ, it also contains the medullary and cortical adrenal homologs and hematopoietic tissue. Kidney is situated along the dorsal wall of the body cavity. Based on location and function kidney of teleost fish has been classified into two types they are:- 1) anterior or head kidney, and 2) posterior or trunk kidney.

Anterior kidney loses its excretory role after the fish matures and mature anterior kidney is the primary hematopoietic organ in adult teleosts. It is the first lymphoid organ to possess sIg⁺ cells. Based on the species the anterior kidney may be bifurcated or single extension. B cells will generate and mature in head kidney. Anterior kidney can even act as secondary lymphoid organ.

Secondary lymphoid organs

Secondary lymphoid organs contains kidney, spleen, mucosa.

Kidney

The head kidney which also works as secondary lymphoid organ is important in mounting immune response. The head kidney is a major organ where antibody producing cells are formed. The presence of monocytes, macrophages and neutrophils and the lack of lymphocytes in the early life of many fish species indicate the importance of innate immune system during early stage of life. The mature kidney in Indian major carp contains mostly lymphocytes besides other blood cells.

Spleen

Spleen is the secondary lymphoid organ and it is the last organ to form during the development of the lymphoid organs in teleosts. In most teleosts, the spleen is present as an encapsulated organ with abundant red pulp and poorly developed white pulp but in majority of the teleosts these pulp are not clearly distinct. The red pulp occupies most of the space in spleen and contains lymphocytes and macrophages. The white pulp occupies less space and contains poorly developed ellipsoids and numerous melano-macrophage aggregations. Ellipsoids purifying the blood by trapping immunocomplexes and later digested by the macrophages.

Mucosa

Mucosa is highly diffused and unorganized lymphoid tissue that consists of granulocytes, macrophages in the gut, gills and skin. These lymphoid tissue occur mainly under the epithelial cells of the gut and in lamina propria. Macrophages and sIg⁺ lymphocytes also present in the mucosal lymphoid tissues