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The mast cell

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Abstract

Mast Cells are important immune cells in all species of vertebrates. They are pivotal in the non-specific immune response, especially associated with allergic reactions of the skin. They are produced in the bone marrow as are other immune cells and their presence may induce beneficial as well as harmful immune reactions.

Introduction

Mast cells are immune cells that are arguably the most closely associated cell type with allergic reactions. They were originally discovered by Frederick von Recklinghausen in 1863 and named by Paul Ehrlich in 1877 [1]. They originate in the bone marrow, but unlike other types of cells such as basophils they mature while circulating in the body, usually when reaching a specific tissue site. Mast cells are a common "participate" not only in allergic reactions but also in wound healing, immune tolerance and importantly in defense against pathogens [2]. As mentioned, they are similar to the basophil in terms of function and appearance. Both cells express CD34. Mast cells are present in most tissues are very prevalent near the skin surface and mucosa and conjunctiva. Allergic reactions of the eye may be the most reported types of allergic reaction, simply because they are the most "visible" to both the victim and to others and may in rare cases lead to blindness.

Functions

Histamine release

Histamine is involved in immune reactions and consists of an imidazole ring attached to an ethylamine chain. It is produced by mast cells (and basophils) in response to pathogens of all kinds, including food intolerance [3,4]. Mast cells (and basophils) display as part of the cell surface the FceRI high-affinity receptor for IgE. It is a tetramer consisting of an alpha chain, a tetraspan beta chain and two di-sulfide linked gamma chains. Anaphylaxis may be triggered when an allergen (or other stimulant) interacts with IgE antibodies which may be located on the surface of the mast cell [5]. This triggers de-granulation with the subsequent release of inflammatory mediators including histamine. When histamine is released in response to a pathogen interacting with mast cell surface receptors which have interacted and become sensitized by IgE, itching, redness and vasodilation occur quickly, often within seconds [6]. Vasodilation may result in lower the blood pressure. It also increases blood vessel permeability. The "flare and wheel" reaction on the skin's surface are signs of histamine release as it relates to the depolarization of nerve endings. This sign in maximal for about 30 minutes and resolves in about an hour. Insect bites are characterized by a noticeable bump and redness which occurs within seconds of mast cell interaction with an insect allergen. Anaphylaxis is the systemic reaction to allergens and may be life threatening [5,6]. It is caused by the body or system wide degranulation of mast cells leading to vasodilation caused by histamine release.

Structure

Mast cells are similar to basophils in terms of structure [7]. They are both granulated and contain heparin, but as mentioned mast cells will mature while circulating in the body. The mast cell nucleus is round. CD 34 is expressed as in the basophil. They mature in the presence of cytokines such as nerve growth factor (NGF). Granules in mast cells may be stained by Toluidine Blue and appear purple post-stain.

In tissues mast cell progenitor cells express the IgE receptorFceRI, just as mature mast cells do. Migration of these immature cells is dictated by the presence of inflammation and thus inflammatory mediators. Mast cells are especially prevalent around blood vessels. They are common in the skin, lungs and digestive tract, and especially important in the eye and nasal cavities [8].

Clinical significance

Activated mast cells play an essential and well-established role in allergy and inflammation processes. The presence of allergens will cause mast cell to degranulate by in an essentially irreversible linkage to IgE receptors. Degranulation of mast cells leads to the presence of inflammatory mediators in the immediate microenvironment of the cell.

Mast cells are in relatively high numbers associated with the skin. They may also occur in the intestinal submucosa and various connective tissue [9]. As a result of incoming inflammatory cells to a given area of the skin more cells are recruited and thus the reaction continues. This condition may be treated with cyclosporin or methotrexate. Chronic urticaria (hives) is a condition of the skin and may be caused by an allergic reaction to a food or drug [10]. It is triggered by de-granulation of mast cells. As intra-cell inflammatory mediators are released, the acute inflammatory response mediated by lymphocyte and granulocyte induced hypersensitivity reaction. As a result, more cells are recruited with the subsequent release of more soluble inflammatory mediators. The end results are redness, welts, bumps or raised lessons on the

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skin surface that will cause an uncontrollable itch. Treatment is with antihistamines and in some cases steroids [10].

Another role that mast cells have is in the pathology and development of multiple sclerosis (MS) [11]. MS is a progressive disease which causes lessons in the brain and spinal cord. Signs and symptoms include incontinence, motor dysfunction and vision problems. Further there is memory loss, and a general slowness to process information or to perceive when visual information is incorrect. Mast cells release cytokines which recruit other immune cells such as T cells to a given area. Mast cells have the ability to disrupt the blood brain barrier that will allow these T cells to infiltrate the brain and interfere with myelin basic protein. Mast cells can damage myelin. As a result, tryptase is released, which in turn acting as a degenerative feedback mechanism to further stimulate inflammation including the further recruitment of immune cells.

Mast cells have a role in the development of the autoimmune disease rheumatoid arthritis (RA) [13]. RA is a systemic disease that affects about 1% of the population. Most of the major cell types have a role in this disease. There has been shown to be a link between the presence of mast cells and the development of RA in synovial tissues. They produce inflammatory mediators. The activation of mast cells through the IgG immune complex can initiate inflammation through the release of IL-1. TNF-alpha can induce fibroblasts to produce stem cell factor, which serves as a feedback recruitment loop for mast cells which in turn produce more inflammatory mediators and thus continues the disease in the affected areas [13].

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