

# The basophil

Clyde Schultz\*

Department of Biology, The University of Calgary, Alberta, Canada

## Abstract

Basophils are large multi-lobed cells that circulate in the blood of humans and other animals. They are structurally and genetically related to neutrophils and eosinophils and they originate in the bone marrow. They have a variety of clinical functionalities and disease syndromes associated with their presence but perhaps the most important and certainly the most studied surrounds allergic reactions.

## Introduction

Basophils are a member of a group of cells discovered by Paul Ehrlich in the 1879 [1]. They are referred to as a “white cell” comprising no more than 1% of this cell type [2]. They are the least common but largest of the granulocytes which include neutrophils and eosinophils, the other two groups of white cells. Basophils have the capability to produce histamine, serotonin, and are at least partially responsible for various allergic (immune) reactions in the body. If basophil levels are low, it may in certain circumstances (such as helminth infections) take longer for the body to respond to infections. Under these circumstances, patients are more at risk for more serious complications and in rare cases death.

## Structure and development

These cells develop in the bone marrow as do neutrophils and eosinophils. The life span of a basophil is reported to be no more than 70 hours [3]. Basophils develop from a precursor cell common to both eosinophils and neutrophils [4]. The mechanism by which basophils develop as distinct cell types from these other cell types is poorly understood, but appears to coincide by the appearance of IL-3. IL-3 has been shown to drive maturation from bone marrow precursor cells. Human basophils circulate and may be recruited to sites of an inflammatory response, but will not be found in normal tissue, unlike mast cells [5,6]. Basophils develop from hemopoietic stem cells with the influence of a myeloid progenitor. Development will continue as a pre-basophil/mast cell progenitor in the bone marrow or spleen. Mature basophils are released into the blood stream, where they await stimulation from some source, often an allergen. They may also be activated by immunoglobulin, cytokines or other growth factors, or bacteria or bacterial sub-particles, especially as regards parasites, virus or as mentioned allergens.

## Function

Basophils have some synergy with mast cells in terms of the mediators that are produced such as vascular endothelial growth factor (VEGF). Basophils produce other cytokines such as IL-4, IL-6 and IL-13 [7]. Basogranulin is produced and released when a given basophil de-granulates [8]. The only lipid identified mediators produced are platelet activating factor and the cysteinyl leukotriene, LTC<sub>4</sub> [9]. It has been reported that antigen-presenting basophils are important

in the development of Th2 immunity [10, 11]. These cells along with the appearance of IL-4 appear to be critical in the development of Th2 immunity [12]. These findings are supported by studies which show that basophil depletion will compromise parasitic repulsion.

However, these findings are in dispute with data from other investigations which have shown that basophils are not necessary for Th2 immunity to develop. In a study with *Schistosoma* infections it was shown that dendritic cell depletion (in mice) was sufficient to disrupt Th2 immunity to the infection. This study demonstrated that basophil depletion had no effect on Th2 induction, at least in this mouse model [13]. These findings though are in contrast to the vast majority of other literature and tend to contradict the human generated literature on the subject.

## Clinical significance

As with various cell types and soluble mediators, basophils have both a beneficial and destructive affect in the body [14,15]. Basophils may infiltrate feeding sites of scabies mites. When basophils are not present, extensive scabies manifestation occurred in a patient not containing either eosinophils or basophils. In this instance increased levels of basophils are of therapeutic advantage.

However, when basophils are present in increased numbers there is an underlying reason often involving a disease cycle. As mentioned, the most well studied area of basophil influence is in the area of allergy. Basophils have receptors on the surface of the cell that will bind to IgE which is essential in the release of histamine and PAF. The release of these molecules leads to typical signs and symptoms of an immediate allergic reaction such as itch and including anaphylaxis, which may be life threatening. In the ocular environment this may include redness, burning and exudate production. Within 12 hours of an immediate allergic response late phase reactions such as asthma may occur [16].

Basophils may contribute to lupus nephritis development in patients showing higher than normal cell levels, responsiveness, and the

\*Correspondence to: Clyde Schultz, Department of Biology, The University of Calgary, Alberta, Canada, Tel: 4032205278; E-mail: schultzc@ucalgary.ca

**Key words:** immune, granulocyte, inflammation, cytokine

**Received:** February 05, 2020; **Accepted:** February 14, 2020; **Published:** February 17, 2020

presence of elevated serum IgE autoantibodies. The model suggests that IgE anti-dsDNA/dsDNA bound to basophil receptors cause activation especially in lymphoid tissue and organs. These activated basophils produce IL-4 that enhance autoantibody production, thus resulting in a disease cycle.

There is evidence that basophils are associated with and contribute to malignancy especially myeloid leukemia [17]. Increased numbers of blood basophils (upto 70%) have been detected in patients with chronic myeloid leukemia [18]. Relative to other negative outcomes, increased levels of basophils >250 microliter [a condition known as basophilia] have been associated with adverse outcomes in patients with myelodysplastic syndromes. Signs and symptoms of basophilia include fatigue, itching due to the release of histamine, muscle aches and stiffness.

### References

- Ehrlich P (1879) Contributions to the knowledge of granulated connective tissue cells and eosinophilic leukocytes. *Arch Anat Physiol* 3: 166-169.
- Schroeder J (2009) Basophils beyond effector cells of allergic inflammation. *Adv Immunol* 101: 123-161.
- Iwasaki H, Akashi K (2007) Myeloid lineage commitment from the hematopoietic stem cell. *Immunity* 26: 726-740
- Arinobu Y, Iwasaki H, Gurish MF, Mizuno SI, Shigematsu H, et al. (2005) Developmental checkpoints of the basophil/mast cell in adult murine hematopoiesis. *PNAS (USA)* 102: 18105-18110.
- Arock M, Schneider E, Boissan M, Tricottet V, Dy M (2002) Differentiation of human basophils: an overview of recent advances and pending questions. *J Leukoc Biol* 71: 557-564.
- Valent P, Schmidt G, Besemer J, Mayer P, Zenke G, et al. (1989) Interleukin-3 is a differentiation factor for human basophils. *Blood* 73: 1763-1769.
- Sullivan B, Locksley RM (2009) Basophils: a non-redundant contributor to host immunity. *Immunity* 30: 12-20.
- Mochizuki A, McEuen AR, Buckley MG, Walls AF (2003). The release of basogranulin in response to IgE: dependent and IgE-independent stimuli: validity of basogranulin measurement as an indicator of basophil activation. *J Allergy Clin Immunol* 112: 102-108.
- Karasuyama H, Mukai K, Tsujimura Y, Obata K (2009) Newly discovered roles for basophils: a neglected minority gains new respect. *Nat Rev Immunol* 9: 9-13.
- Sokol C, Medzhitov R (2010) Role of basophils in the initiation of Th2 responses. *Curr Opin Immunol* 22: 73-77.
- Wynn T (2009) Basophils trump dendritic cells as APCs for Th2 responses. *Nat Immunol* 10: 679-681.
- Perrigoue JG, Saenz SA, Siracusa MC, Allenspach EJ, Taylor BC, et al. (2009) MHC class II-dependent basophil CD4 T cell interactions promote Th2 cytokine-immunity. *Nat Immunol* 697-705.
- Phythian-Adams AT, Cook PC, Lundie RJ, Jones LH, Smith KA, et al. (2010) CD11c depletion severely disrupts Th2 induction and development *in vivo*. *J Exp Med* 207: 2089-2096.
- Wada T, Ishiwata K, Koseki H, Ishikura T, Ugajin T, et al. (2010) Selective ablation of basophils in mice reveals their nonredundant role in acquired immunity against ticks. *J Clin Invest* 8: 2867-2875.
- Ito Y, Satoh T, Takayama K, Miyagishi C, Walls AF, et al. (2011) Basophil recruitment and activation in inflammatory skin diseases. *Allergy: Europ J Allergy and Clin Immunol* 66: 1107-1113.
- Juhlin I, Michaëlsson G (1977) A new syndrome characterized by absence of eosinophils and basophils. *The Lancet* 309: 1233-1235.
- Cromheecke J, Nguyen KT, Huston DP (2014) Emerging role of human basophil biology in health and disease. *Curr Allergy Asthma Rep* 14: 1-15.
- Stacchini A, Demurtas A, Godio L (2011) Flow cytometry detection of degranulated basophils in chronic myeloid leukemia in accelerated phase. *Clin Cyto* 80: 122-124.