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Phylogeny and Mucosal System of Gnathostomes and Agnathans

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Description

All animals, vertebrate or invertebrates, faces the challenges of combating pathogens while maintaining a tolerant relationship with symbiotic microorganisms. Tolerance to symbiotes is not a static or inert interaction but rather, required continuous active regulation of the front lines for these interactions with the mucosal surfaces. A fundamental question is whether or not specialized immune cells or organs have evolved in all animals to cope with the unique problems of mucosal defense, or whether specialized mucosal immunity is unique to vertebrates such as mammals. This question can be answered by investigating the phylogeny of the mucosal and systemic immune system, from invertebrates to fish, amphibians, reptiles and birds to prototherians, the metatherians and eutherians. There is also, an extremely practical reason for studying phylogeny of many species and suffer from diseases of mucosal surfaces so that producing mucosal vaccines against fish pathogens is arguably as important to humankind as producing vaccines against the mucosal pathogens of mammals. Most of the paradigms for immune defences and symbiosis were established from studies of humans and a few other mammalian species such as rodents. Although these studies have provided more than a century of discovery and progress, much has also been learned from non-mammalian vertebrates as well as invertebrates, particularly over the past two decades.

The unique aspect of adaptive immune system is the generation of diverse receptors from germline DNA. Among the animal phyla, the chordates arguably exhibit the greatest diversity in immune systems. Vertebrates are divided into Gnathostomes and Agnathans. These two lineages have adaptive immune systems that followed very different evolutionary paths while maintaining some common features. Both lineages use lymphocytes as the major cell type mediating adaptive immunity.

T cell receptors in gnathostomes

These lymphocytes express cell surface, antigen specific and clonally unique receptors. In all gnathostomes, the T-cell antigen receptors are composed of a heterodimers. The genes encoding these four chains are highly conserved both in sequence and organization from sharks to mammals, leading to the conclusion that the TCR performs common functions across all the gnathostome lineages, principally as recognition, Unlike antibodies that serve both as signalling receptors and are also secreted, the TCR serves solely to recognize antigenic epitopes when they meet a threshold of binding affinity. The requirement of recognizing antigenic peptides and glycolipids presented on molecules encoded by the major histocompatibity complex has further contrained the evolution of T cell receptors. The relationship between T-cell receptor and major histo compatibility complex is also ancient in the gnathostomes and conserved in all living species.

T cells in agnathans

In agnathans there are discrete lymphocyte subsets. One subset does not secrete its antigen receptor but is capable of producing cytokines that regulate other cell types. In gnathostomes these are the T cells whereas in agnathans they are lymphocytes. Also present is subset that is capable of producing its antigen receptor both as cell surface receptor and as a secreted molecule, often in a polymeric form. These are the B cells in gnathostomes and lymphocytes in agnathans. Therefore, the paradigm of the dichotomy between B and t cells in mice and humansproably arose in a common vertebrate ancestor more than 500 million years ago, before the evolution of the thymus, spleen, TCR, Immunoglobulins, and other structures with which most immunologists are familiar.