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## [2] Fish and Shellfish Bio-Defense

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## **FISH AND SHELLFISH BIO-DEFENSE**

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### **Summary**

The aquatic environment harbors many microorganisms such as viruses, bacteria, fungi and protozoa. In addition, many survive in their intestines and enter into their body through intake of food or water. These intestinal or environment microorganisms are trying to invade the fish body, but their invasion and proliferation are prevented by the bio-defense mechanisms in a healthy fish. The first line of defense is non-specific innate immune system which is important especially in fish as a lower vertebrate. The humoral and cellular factors involved in the innate immune system in fish are introduced in Section 1.

Microorganisms escaped from the first barrier come across with the second line of defense, adaptive immune system characterized by the specificity and memory. Teleosts and elasmobranchs possess adaptive immunity akin to mammalian one having Igs,

MHC/ TCR system and B cells, T cells. Humoral and cellular components involved in adaptive immune system are described in Section 2 together with different characteristics of fish immune system compared to those of mammals.

Shrimp aquaculture is expanding all over the world and the importance of understanding their immune system is greatly increasing to protect from infections. However, little is known about the innate immune systems possessed by shrimp particularly the mechanisms involved at the molecular level. Current knowledge on immune responses of shrimp focusing on the phenol oxidase system, antimicrobial peptides/proteins and blood clotting system is presented in Section 3.

Shellfish production is also growing worldwide. Shellfish, as well as other invertebrates, do not possess adaptive immunity and rely on an innate immune system. Cellular and humoral bio-defense in shellfish are described in section 4 focusing on hemocytes which migrate to and phagocytose invading microorganisms and humoral defense factors involved in the recognition of pathogenic microorganisms and the microbial killing and macromolecular degradation.

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## **1. INNATE IMMUNITY IN FISH**

*Takashi Aoki and Jun-ichi Hikima*

### **1.1. Synopsis**

The aquatic environment where fish live harbors many microorganisms such as bacteria, fungi and protozoa. In addition, many survive in their intestines that enter their body through intake of food or water. These intestinal or environment microorganisms are trying to break into the fish body continuously, but their invasion and proliferation are prevented by the bio-defense mechanisms in a healthy fish. It is considered that non-specific innate immune system is important especially in fish as a lower vertebrate.

The innate immune system involves both humoral and cellular mechanisms and can be divided into four phases: 1) first, is protection effected by the barrier of mucus on the body surface, gills and in intestine; 2) then the pathogen that made its way into the host is phagocytosed by immune-related leukocytes (antigen presenting cells or APC); 3) pathogens are recognized by various receptors and then bio-defense systems it started; 4) finally, cellular defense mechanism activates acquired immunity as a specific immune mechanism.