the form of protein complexes of poly-peptides showing a selective affinity to critical elements of the central or peripheral nervous system. In this way they give almost unlimited possibilities of research: concerning the nervous system in higher organisms. Moreover, the fact that animal toxins act even when applied in micro-quantities makes possible to extend the scope and increase the sensitivity of such research.

Three indices placed at the end of the book concerning, successively; the problems discussed; analytical procedures applied; and the most commonly met practical difficulties, are a significant asset of the monography on animal toxins.

To sum up, the book discussed is an irreplaceable source of specific information, well adapted to contemporary requirements and most useful for all those who, studying various disciplines of biosciences, are interested in toxins of animal origin. This applies particularly to those whose work involves research on the mechanisms of pharmacological and neurotozic activity of chemical compounds, as well as techniques of their safe application, especially in medicine.

J. Brzeziński

Chitin and Chitinases. Edited by P. Jolles and R.A.A. Muzzarelli, Birkhäuser Verlag, 1999, ISBN 3764358157

As the title indicates, this book is devoted to all aspects concerning chitin, the most abundant nitrogen-bearing organic compound found in nature. At least 10^{13} kg of chitin are synthesized and degraded each year in the biosphere. Chitin, the insoluble polymer of *N*-acetylglucosamine (GlcNAc) is used by many organisms as a structural component of the protective cell walls or exoskeletons which surround them. Chitin is present in insect exoskeletons, crustacean shells, fungal cell walls and cyst wall of the protozoan parasites, in a form of microfibrils immersed in a matrix of proteins and other polysaccharides. The resulting structures behave like composites. Chitin-protein complexes provide hardness combined with flexibility. Association with lipoproteins and waxes provides impermeability properties to exoskeleton. Some chitin oligosaccharides are engaged in plant morphogenesis.

The first part of this book offers detailed information on chitin biosynthesis. Authors discuss the biochemistry of chitin synthesis *in vitro*, chitin biosynthesis and structural organization *in vivo*, as well as role of chitin synthases. In all the systems studied so far, synthesis of chitin occurs as a result of a transglycosylation reaction catalysed by enzymes collectively called chitin synthases which utilize the nucleotide uridine diphosphate *N*-acetylglucosoamine (UDPGlcNAc) as the sugar donor. Authors describe the mechanisms involved in chitin biosynthesis *in vivo*, its transport to the exocellular space where it crystallizes in the form of microfibrils, its most common modifications and its association with other molecules in order to give rise to the protective structures which surround the organisms.

Because of its insolubility it has been generally accepted that chitin is deployed in the extracellular space. Nevertheless, soluble precursors and the polymerizing enzyme chitin synthase itself are synthesized intracellularly. Chitin is synthesized in two different ways: in fungi the chitin synthase enzyme occurs as an inactive zymogen in vesicles called chitosomes and requires proteolytic activation. In arthropods this enzyme is membrane-bound. Although the mechanisms for the deployment of chitin in the exocellular structures appear to be different in the several organisms analyzed, all of them finally lead to its crystallization in the form of microfibrils. Three different crystalline polymorphic forms of chitin exist under natural conditions.

Chitin synthesis has been described in several systems, but the yeast cell wall is the most extensively studied. The use of budding yeast *Saccharomyces cerevisiae* as a biological model allowed identification of three distinct chitin synthases differing in the catalytic properties and functions. Chitin synthase has probably undergone sequential gene duplication and divergence during evolu-

tion and at present is manifested in different forms in diverse species, one of which is the human hyaluronidase syntase. This enzyme has the conserved amino-acid sequence essential for chitin biosynthesis in yeasts. Chitin synthase is thought to have evolved into two types, the fungal form, which occurs as an inactive zymogen and the membrane-bound arthropod form.

The process of chitin formation can be blocked at any biosynthetic step by various inhibitors. A wide variety of chitin synthesis inhibitors belonging to different chemical groups are presented in this book. Chitin synthesis inhibitors are promising agents for controlling insect pests, fungal pathogens and helminthic parasites.

The second part of the book focuses on chitinases, which split the β-1,4-glucosidic bonds of chitin. Chitinases fall into two unrelated families of glycosyl hydrolases, distinguished by the amino-acid sequences and having different hydrolytic mechanisms.

Chitin containing-organisms produce chitinases degrading the exoskeletal chitin in the cuticle or shell before ecdysis. Nevertheless, some organisms deprived of chitin, such as a wide variety of bacteria, algae, higher plants and vertebrates also produce chitinases. In seaweeds and higher plants chitinases are used for defense against fungal pathogens and pests. Chitinases are major component of plant "pathogenesis-related proteins" induced following attack by pathogen. Some of these chitinases have direct antifungal activity. Microorganisms produce chitinase to digest the chitinous nutrient or to partially hydrolyse chitinous cell wall for cell proliferation. Recently chitinases were even found in fishes and mammals which may utilize them as defence agents against pathogenic fungi and some parasites.

While chitin is absent in mammals, all of the species studied shown to express chitinase-like proteins. These proteins are devoid of chitinolytic activity due to amino acid substitution in the region corresponding to the active site of chitinases. However, their phylogenetic conservation predict significant biological role(s) not yet known. One of these chitinase-like proteins is oviductin, most likely involved in fertilization.

Chitinases are produced by a wide variety of pathogenic and parasitic microbes and invertebrates during their attack on chitin-containing organisms. Examples presented in corresponding chapters include enzymes of insect and algal viruses, of yeast killer toxin plasmids, of bacterial and fungal pathogens of fungi and insects, and of parasitic protozoa. These chitinases play crucial roles in penetration of chitin-containing protective barriers. Salivas of some invertebrate predators have chitinolytic activity which may be involved in their attack on their prey.

A number of entomopathogenic and mycoparasitic fungi producing chitinases are being investigated for their potential as biocontrol agents against insect pests and fungal plant pathogens. There has been much interest in the possibility of increasing the natural defences of crop plants against fungal and pests attack by creating transgenic plants expressing chitinase genes from bacteria, fungi, plants and insects.

The third part of the book is devoted to chitosan, an important chitin derivative. Chitosan indicates a family of deacetylated chitins. Chitosan can be easily obtained from fungi. Its biosynthesis occurs by the deacetylation of chitin, rather than by *de novo* biosynthesis. Mechanical properties of chitosan make it appropriate as a cementing compound. In arthropods, chitosan allows stretching of the cuticle, including extreme cases (queen of termites).

Studies performed over the last few years have directed chitins and chitosans to the forefront of applied medical research, offering valuable medical items in the field of general medication, wound healing, plastic surgery, drug carriers and immunostimulators.

Dietary chitosan exhibits hypocholesterolemic, antiulcer, antiarthritic, antihypertension and antiuricemic properties. The antimicrobial activity of chitosan is well observed on a wide variety of micro-organisms including fungi, algae and some bacteria.

My overall impression is that "Chitin and Chitinases" provides valuable information not only for scientist working with chitin-containing organisms.

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