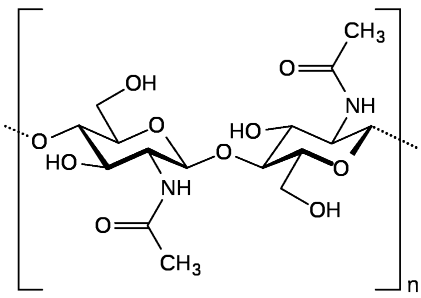
Chitin

Chitin $(C_8H_{13}O_5N)_n$ (/ˈkaɪtɪn/) is a long-chain polymer of a *N*-acetylglucosamine, a derivative of glucose, and is found in many places throughout the natural world. It is the main component of the cell walls of fungi, the exoskeletons of arthropods such as crustaceans (e.g., crabs, lobsters and shrimps) and insects, the radulas of mollusks, and the beaks of cephalopods, including squid and octopuses. In terms of structure, chitin may be compared to the polysaccharide cellulose and, in terms of function, to the protein keratin. Chitin has also proven useful for several medical and industrial purposes.



Structure of the chitin molecule, showing two of the *N*-acetylglucosamine units that repeat to form long chains in β-1,4 linkage.

Etymology

The English word "chitin" comes from the French word *chitine*, which first appeared in 1836. These words were derived from the Greek word *chitōn*, meaning mollusk, that is, influenced by the Greek word *khitōn*, meaning "tunic" or "frock". That word may come from the Central Semitic word **kittan*, the Akkadian words *kitû* or *kita'um*, meaning flax or linen, and the Sumerian word *gada* or *gida*.[1]

A similar word, "chiton", refers to a marine animal with a protective shell (also known as a "sea cradle").

Chemistry, physical properties and biological function

The structure of chitin was solved by Albert Hofmann in 1930. Chitin is a modified polysaccharide that contains nitrogen; it is synthesized from units of *N*-acetylglucosamine (to be precise, 2-(acetylamino)-2-deoxy-D-glucose). These units form covalent β-1,4 linkages (similar to the linkages between glucose units forming cellulose). Therefore, chitin may be described as cellulose with one hydroxyl group on each monomer substituted with an acetyl amine group. This allows for increased hydrogen bonding between adjacent polymers, giving the chitin-polymer matrix increased strength.

In its unmodified form, chitin is translucent, pliable, resilient, and quite tough. In arthropods, however, it is often modified, becoming embedded in sclerotin, a tanned proteinaceous matrix, which forms much of the exoskeleton. In its pure form, chitin is leathery, but in most invertebrates it occurs largely as a component of composite materials. Combined with calcium carbonate, as in the shells of Crustacea, it produces a much stronger composite, harder and stiffer than pure chitin, tougher and less brittle than the mineral substance alone.[2] Another difference between pure and composite forms can be seen by comparing the flexible body wall between the segments of a caterpillar (mainly chitin) to the stiff, light elytron of a beetle (containing a large proportion of sclerotin).[3]


A cicada sheds its chitinous exoskeleton.

Fossil record

Chitin was present in the exoskeletons of Cambrian arthropods such as trilobites. The oldest preserved chitin dates to the Oligocene, about 25 [4] million years ago, comprising a scorpion encased in amber.[5]

Uses

Agriculture

Most recent studies point out that chitin is a good inducer for defense mechanisms in plants.[6] It has also been assessed as a fertilizer that can improve overall crop yields.[7] The EPA regulates chitin for agricultural use within the USA.[8] Chitosan is prepared from chitin by deacetylation.

Industrial

Chitin is used in industry in many processes. It is used as an additive to thicken and stabilize foods and pharmaceuticals. It also acts as a binder in dyes, fabrics, and adhesives. Industrial separation membranes and ion-exchange resins can be made from chitin. Processes to size and strengthen paper employ chitin..

Also, there is potential for applications in solar cells and cell phone screens;[9] when chitin is treated in hydrochloric acid, sodium hydroxide and ethanol to strip the material of minerals, proteins, lipids, fats and pigments, and supplemented with acrylic resin monomer, a clear product results. Crushed and spread into a nanocomposite film it forms a useful component for solar cell and cell phone screens.

Medicine

Chitin's properties as a flexible and strong material make it favorable as surgical thread. Its biodegradibility means it wears away with time as the wound heals. Moreover, chitin has some unusual properties that accelerate healing of wounds in humans.[10]

Occupations associated with high environmental chitin levels, such as shellfish processors, are prone to high incidences of asthma. Recent studies have suggested that chitin may play a role in a possible pathway in human allergic disease. To be specific, mice treated with chitin develop an allergic response, characterized by a build-up of interleukin-4-expressing innate immune cells. In these treated mice, additional treatment with a chitinase enzyme abolishes the response.[11]

Biomedical Research

Chitin may be employed for affinity purification of recombinant protein. A chitin binding domain is genetically fused to a protein of interest and then contacted to beads coated with chitin. The immobilized protein is purified and released from the beads by cleaving off the chitin binding domain.

References

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External links

- Horseshoe Crab Chitin Research (http://www.ocean.udel.edu/horseshoecrab/Research/chitin.html)
- Information about Chitin (http://www.gmp-chitosan.com/en/products-services/chitin.html) (Heppe Medical Chitosan)
- Chitin (http://www.nlm.nih.gov/cgi/mesh/2011/MB_cgi?mode=&term=Chitin) at the US National Library of Medicine Medical Subject Headings (MeSH)
- Chitin Product Information from China GreatVista Chemicals (http://www.greatvistachemicals.com/biochemicals/chitin.html)

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