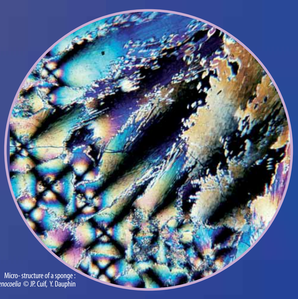
Mineralization in living organisms: shellfish and pearls

Biomineralization is the process by which living organisms produce and organise mineral structures.



Micro- structure of a sponge: *Solenocaelia* © JP. Cuif, Y. Dauphin

A controlled form of crystallisation

The snail and the oyster have different types of shell made of calcium carbonate (limestone) crystals (**CaCO3 calcite or aragonite**). The differences in the arrangement (the **microstructure**) of the calcium carbonate crystals in these shells provides proof that the crystallisation of the shell is biologically controlled by the living organism, each species generating its own structure.
Researchers have attempted to understand the peculiarities of this **biologically controlled crystallisation** process. To achieve this, they study the distribution of the organic phases to a sub-micrometric scale (smaller than one millionth of a metre) and the nano-structures of the biocrystals using optic and electron microscopes and synchrotron radiation.

Living beings are manufacturers of calcium carbonate

Limestone is a widespread sedimentary rock form, resulting from the accumulation of the shells and skeletons of marine animals on the seabed over 540 million years.

Proven properties and multiple applications

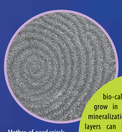
Shale-limestone bio-crystals are one of the wonders of nature. They are used for their microstructural and biochemical properties, which have been tried and tested over millions of years. Applications include:
- the monitoring of aquaculture sites victim to diseases affecting the mineralization of the shells
- the use of coral in bone restoration surgery
- the production of cultured pearls, which has transformed the traditional pearl diving sites (home to pearl-producing oysters) into a modern industry.

Shell (*Strombus gigas*), Caribbean. Coll. Muséum de Grenoble

Mineral production is common in the marine environment but rare amongst land plants and animals. The snail's shell is a very rare terrestrial example, compared to the diversity of shellfish. These living species produce crystal assemblies with controlled shape, starting from identical initial material (calcium carbonate CaCO3): the **microstructure** of the shell is a unique signature of each species.

The geological limestone cycle involves living land or marine animals forming layers of sediment, once dead. The crystals of biological origin from these sediments and limestone fossils provide precious archives bearing witness to the environmental conditions of the long-distant past.

Gastropod fossils (*Lapparia muscalli*) Coll. Muséum de Grenoble



Mother-of-pearl spirals © JP. Cuif, Y. Dauphin

Pearl oyster (*Melegrapina* sp.)

During bio-calcification, crystals grow in micron-thin layers of mineralization. These superimposing layers can be seen using electron microscopes. The biochemical control of the bio-crystallization process could be explained by the introduction of organic layers determining which areas are subject to crystallization.