

Origins of biomineralization in multicellular animals

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Despite controversies concerning when and how on earth the animals originated and various body plans diversified, it is beyond dispute that the Cambrian explosion is real at least in terms of how animal skeletons were established. Detailed mechanisms that underlie this abrupt and simultaneous appearance of controlled biomineralization in various animal lineages are still enigmatic, but it is generally agreed that this ability evolved independently a number of times. The notion of independent origins has recently been reinforced by molecular characterization of both the matrix proteins contained in those skeletons (e.g., secretory calcium-binding phosphoproteins in vertebrate bones and teeth, Asp-rich proteins in molluscan shells, and various other skeletal matrix proteins in sponges, corals, shrimps, sea urchins, etc.) and transcription factors that control to materialise such hard tissues as vertebrate bones and cartilage (BMPs, Smad, Cbfa1, SOX9, etc.), echinoderm spicules (Ets, HNF6), and molluscan shells (engrailed). Deployment of different genetic switches and matrix proteins in those animals in apparently very well organised fashion suggests that production of each of these biominerals is a highly functional and complex process, which may not be induced by simple and single extrinsic factors, such as temperature, oxygen levels, and chemical composition of the ocean, although they may well have been prerequisites for the skeletons to be formed.