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Ferritin protein nanocages—the story

ABSTRACT. Ferritins are a family of large (10–12 nm diameter), self-assembled, protein cages that reversibly synthesize $Fe_2O_3{\cdot}H_2O$ with up to 4500 iron atoms in a central cavity, 65 or 270 nm^3; the protein cages without mineral are sometimes called apoferritin. $Fe_2O_3{\cdot}H_2O$ synthesis depends on controlled Fe^{2+} entry though four or eight ion channels, directed transport to multiple Fe^{2+}/O oxidoreductase ("ferroxidase") sites and, in the case of eukaryotic ferritins, guided nucleation and extrusion through channels connecting the active sites to the mineral growth cavity; passage of the diferric oxo catalytic products through the nucleation/extrusion channels allows the eukaryotic ferritin protein cage to influence order in the bulk mineral. Ferritin Fe^{2+}ion channels also control reduction, dissolution, and exit of Fe^{2+} from the mineral with gated pores on the cytoplasmic surface of ferritin cages. Found in anaerobic and aerobic organisms, from archaea and bacteria to higher plants and animals, ferritins are required for life. They provide metabolic iron concentrates for protein cofactor synthesis, and antioxidant activity after stress. Current applications of ferritin nanocages include clinical measurements of trace amounts released into serum, nutritional sources of concentrated iron, nanomaterial templates, biological delivery of nanosensors, and nanocatalysts. Future applications can exploit the nucleation/extrusion channels and other metal-protein sites in ferritins.

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