

Abstract

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Zinc stimulation of bone protein synthesis in tissue culture. Activation of aminoacyl-tRNA synthetase.

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OBJECTIVE: The present investigation was undertaken to clarify the effect of zinc on bone protein synthesis in tissue culture.

METHODS: Calvaria were removed from 3-week-old male rats and cultured for periods up to 96 hr in Dulbecco's Modified Eagle Medium (high glucose, 4500 mg/dl) supplemented with antibiotics and bovine serum albumin. The calvaria were incubated at 37 degrees in 5% CO₂/95% air in the medium containing 10⁽⁻⁶⁾-10⁽⁻⁴⁾ M zinc.

RESULTS: Zinc content in bone cells was increased when the culture was treated with 10⁽⁻⁵⁾ and 10⁽⁻⁴⁾ M zinc for 48 hr. When calvaria cultured in the presence of 10⁽⁻⁴⁾ M zinc were pulsed with [¹⁴C]uridine, the incorporation of [¹⁴C]uridine into the bone RNA was not increased significantly. In the pulse with [³H]leucine, the presence of 10⁽⁻⁵⁾ to 10⁽⁻⁴⁾ M zinc in the medium caused a significant increase in the incorporation of [³H]leucine into the acid-insoluble residues of bone tissue. This increase was blocked completely by treatment with 10⁽⁻⁷⁾ M cycloheximide, an inhibitor of protein synthesis. When [³H]leucine was added into the reaction mixture containing the 5500 g supernatant fraction of the homogenate prepared from calvaria cultured in the presence of 10⁽⁻⁴⁾ M zinc, the in vitro protein synthesis was increased about 2-fold. The activity of [³H]leucyl-tRNA synthetase in the 105,000 g supernatant fraction (cytosol) of the bone homogenate was increased about 2-fold by the culture with 10⁽⁻⁴⁾ M zinc. The presence of 10⁽⁻⁴⁾ M dipicolinate, a specific chelator of zinc, in the culture medium negated the effect of zinc on [³H]leucyl-tRNA synthetase activity. The addition of 10⁽⁻⁷⁾ to 10⁽⁻⁶⁾ M zinc into the reaction mixture containing enzyme extracts obtained from uncultured rat calvaria caused a 2-fold increase of [³H]leucyl-tRNA synthetase activity.

CONCLUSIONS: These results clearly indicate that zinc induces the stimulation of protein synthesis at the translational level in bone cells. The present study further supports the view that zinc increases protein synthesis in bone cells and that the metal induces bone formation.

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