Vitamin D: sites and mechanisms of action
- in bone, cartilage, teeth and skin.
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Autoradiographic studies with $^{3}$H-1,25(OH)$_2$vitamin D$_3$ in rats, mice and hamsters revealed that most organs contain nuclear receptors and that target cells for vitamin D are not restricted to calcium-regulating tissues. Animals injected with 0.1, 0.2, or 0.4ug per 100g bw of radiolabeled vitamin D and sacrificed 2-4 hrs later, showed nuclear uptake and retention of radioactivity not only in intestine, kidney, and parathyroid, but also in brain, pituitary, salivary glands, adrenal, pancreas, thymus, spleen, male and female reproductive organs, and placenta.

In connective tissues, nuclear binding was demonstrated in osteoblasts and osteocytes; in chondroblasts; in incisor and molar teeth pulp cells and, to a lesser degree, in odontoblasts and ameloblasts; in skin epidermis, hair sheaths, and sebaceous gland basal cells, with little or none in dermal and other fibroblasts. In hair dermal papillae fibroblasts, no nuclear binding has been observed with vitamin D. This is in contrast to $^{3}$H-estradiol, $^{3}$H-dihydrotestosterone, and $^{3}$H-retinoic acid, which show nuclear binding to hair dermal papillae. While fibroblasts and keratinocytes show nuclear concentration of all of the above listed steroids, the strong binding of vitamin D to cells of the outer hair sheaths is unique.

Endocrine cells involved in the regulation of growth (protein synthesis) and calcification are also targets for vitamin D. These include pituitary thyrotropes, parathyroid chief cells, gastrin producing cells in the stomach, and B-cells in the endo-crine pancreas.

Regarding the functions of vitamin D in connective tissue target sites, evidence indicates that vitamin D affects regulation of cell proliferation and differentiation, enzymatic activities, and production and secretion of cellular products. Involvement in bone growth and calcification and in the regulation of systemic and cellular calcium levels is only a small part of its many actions. The limited understanding of its roles is reflected in the names "vitamin D" and "calcitriol". Vitamin D is now being recognized as the multifunctional steroid hormone of sunlight. In consideration of its much wider role as a seasonal regulator of vital functions - e.g. growth and reproduction, cardiovascular activity, immune response, nutrition, nervous and autonomic-endocrine actions - we prefer the name "soltriol" (Stumpf WE, Histochem. 89:209, 1988). The existence of both overlapping and singular sites of action for vitamin D-soltriol and sex steroids suggests cooperative (agonistic or antagonistic) and complimenta-ry effects for these steroid hormones.