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Deer antlers as a model of Mammalian regeneration.

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Source

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Abstract

Deer antlers are cranial appendages that develop after birth as extensions of a permanent protuberance (pedicle) on the frontal bone. Pedicles and antlers originate from a specialized region of the frontal bone; the 'antlerogeneic periosteum' and the systemic cue which triggers their development in the fawn is an increase in circulating androgen. These primary antlers are then shed and regenerated the following year in a larger, more complex form. Antler growth is extremely rapid-an adult red deer can produce a pair of antlers weighing approximately 30kg in three months, and involves both endochondral and intramembranous ossification. Since antlers are sexual secondary characteristics, their annual cycles of growth have evolved to be closely coordinated to the reproductive cycle which, in temperate species, is linked to the photoperiod. Cessation of antler growth and death of the overlying skin (velvet) coincides with a rise in circulating testosterone as the autumn breeding season approaches. The 'dead' antlers remain attached to the pedicle until they are shed (cast) the following spring when circulating testosterone levels fall. In red deer, the species that we study, casting of the old set of antlers is followed immediately by growth of the new set. Although the anatomy of antler growth and the endocrine changes associated with it have been well documented, the molecular mechanisms involved remain poorly understood. The case for continuing to decipher them remains compelling, despite the obvious limitations of using deer as an experimental model, because this research will help provide insight into why humans and other mammals have lost the ability to regenerate organs. From the information so far available, it would appear that the signaling pathways that control the development of skeletal elements are recapitulated in regenerating antlers. This apparent lack of any specific 'antlerogenic molecular machinery' suggests that the secret of deers' ability to regenerate antlers lies in the particular cues to which multipotential progenitor/stem cells in an antler's 'regeneration territory' are exposed. This in turn suggests that with appropriate manipulation of the environment, pluripotential cells in other adult mammalian tissues could be stimulated to increase the healing capacity of organs, even if not to regenerate them completely. The need for replacement organs in humans is substantial. The benefits of increasing individuals' own capacity for regeneration and repair are self evident.

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