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Thermogenesis in ectothermic vertebrates

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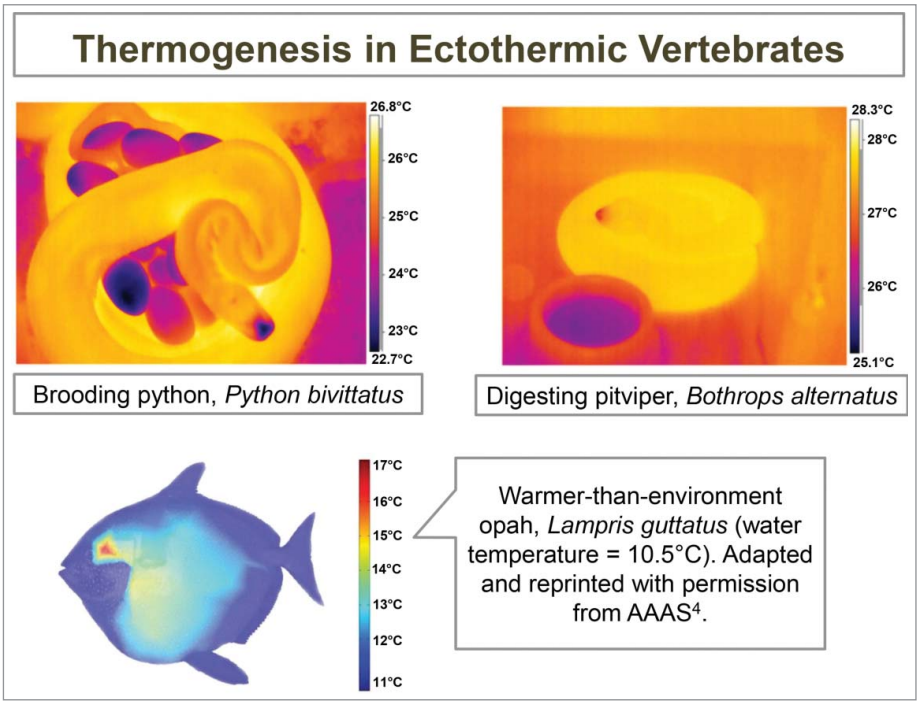
Thermogenesis refers to the production of heat by living organisms as a by-product of metabolic activity and is the principal thermoregulatory effector employed by endothermic organisms. On the other hand, ectothermic organisms depend primarily upon external heat sources and behavioral and physiological adjustments to thermoregulate. This dichotomy is reflected in differences in the level of metabolic activity, orders of magnitude higher in endotherms compared to ectotherms. In vertebrates, endothermy is typically associated with birds and mammals while fishes, amphibians, and reptiles are generally typified as ectotherms. However, there are representatives in the latter group whose body temperature can be significantly influenced by thermogenesis. The use of such examples in teaching extends far beyond the presentation of odd curiosities, as they illustrate the link between metabolic activity, heat generation, and body temperature regulation.

For example, a brooding Burmese python, *Python bivittatus*, coiled around its eggs elevates its body temperature well above ambient by the use of spasmodic muscle contractions (i.e., shivering thermogenesis), which, in turn, are reflected by an increment in metabolic rate.[1] Similarly, some snake species that feed on large prey infrequently exhibit, during digestion, a remarkable increment in the postprandial metabolism, which results in enough heat being produced to impact their body temperature[2] (Slide 1).



Slide 1. Thermal images of thermogenesis in ectothermic vertebrates.

Once heat is generated, its use for thermoregulatory purposes will be optimized by diminishing heat dissipation to the environment. In this regard, endothermic vertebrates are endowed with effective insulation, hairs and feathers, to prevent heat loss. Ectothermic vertebrates, on the other hand, clearly lack such features. However, heat loss to the environment can be decreased by the possession of larger body sizes that increase thermal inertia. This strategy is illustrated by leatherback turtles, *Dermochelys coriacea*, whose gigantic body size associated with relatively high rates of muscle metabolism allows for the maintenance of body temperature much warmer than the cold waters used for foraging.[3] Finally, special circulatory arrangements, such as counter-current heat exchangers within the gills, help to prevent the loss of the metabolically produced heat by the mesopelagic fish, the opah, *Lampris guttatus*[4] (Slide 1).

Keywords: body temperature, heat production, metabolism, thermoregulation, teaching slide

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No potential conflicts of interest were disclosed.

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