

Relevance of DNA Recovery Temperature for Survival of aDNA from Burned Human Remains at Tall al-`Umayri and Khirbet Iskandar

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Summary

Fragmented burned human remains from catastrophic events such as airplane and car crashes, terrorist attacks, and landmines, while modern in age, have yielded DNA sequences despite the high temperatures the skeletal fragments were subjected to. Given advances in scientific analysis it is now possible to sequence DNA from ancient skeletal fragments once thought impossible.

The high levels of preservation of the human remains from Tall al-`Umayri and Khirbet Iskandar, Jordan, along with the fact the fires did not reach the “critical” temperature to destroy all DNA and the careful handling of bones during and after excavation makes it plausible for positive DNA results from the ancient burned human remains recovered at each site.

Research

- hot fire still leaves fragments of dense bones (femur, tibia, petrous) where DNA material can survive
- bodies from house fires (700° C), crematorium (1000° C), and firestorms (2000° C) have had viable DNA
- cortical bone can be charred or calcined but the internal structure and trabecular bone with DNA material left unburned or damaged
- mtDNA yields the best results as it exists in higher numbers per cell than nDNA
- Thorsten Schwark, et al. (2010) put the viability of DNA at 800° C and the vast majority does not survive beyond 900° C due to complete destruction of tissue
- World Trade Towers Ground Zero reached 1100° C yet mtDNA was present in human remains from the rubble
- Color sequence of burned bones happens at a predictable rate based on the fire temperature but is not 100% scientific due to the subjective nature of color. The temperature/color correlation is:
 - tan/beige: 200-300°C
 - brown/black: 300-350°C
 - gray: 550-600°C
 - blue-gray: 600-650°C
 - white: 650°C and higher

Bone Color and Data*

Tall al-`Umayri

Child: 33% tan/beige, 16% brown/black, 100% gray
Mandible U.94.B.7J99.03.003: mitochondrial aDNA

Adolescent: 55% tan/beige, 36% brown/black, 55% gray
No viable aDNA from samples

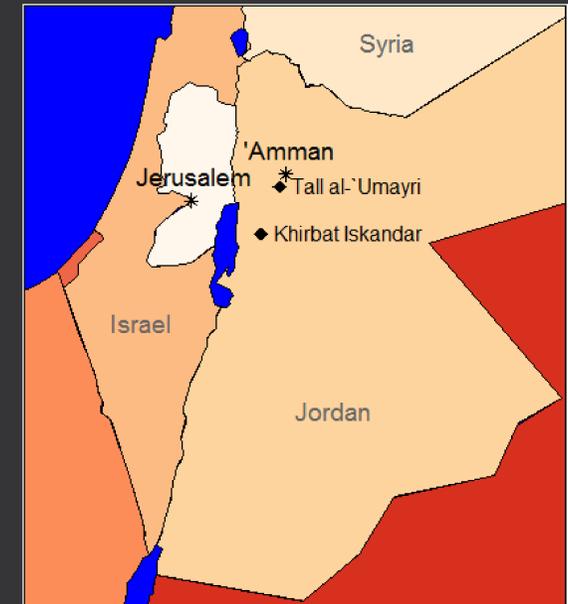
Adults: 67% tan/beige, 0% brown/black, 100% gray
Mandible U.94.B.7J99.03.064: mitochondrial aDNA

Khirbet Iskandar

Adult: 0% tan beige, 100% brown/black, 18% gray
Right ulna KI.04.B.1.28A.149.0011: mitochondrial aDNA

- all skeletal elements resulting in positive mitochondrial aDNA results had no cortical heating above 600°C
- skeletal remains from both sites were in-situ in dark ashy layers, likely discoloring the bones so they appear to have burned hotter than they actually did

*Munsell Color System used; some bones had multiple colors resulting in total percentages over 100%
*due to the fragmentary nature of the `Umayri bones a sampling of 10-15 bones matched to each age group were analyzed; all Iskandar arm bones were analyzed



Tall al-`Umayri adult mandible and teeth
Photo Credit: Vera Kopecky



Khirbet Iskandar adult ulna
Photo Credit: Kristina S. Reed



Tall al-`Umayri bone color variations
Photo Credit: Kristina S. Reed

