Georgian Scientists
ქართველი მეცნიერები
Vol. 8 Issue 4(1), 2026
https://doi.org/10.52340/gs.2026.08.04(1).47

THANATOTRANSCRIPTOME: POSTMORTEM GENE EXPRESSION AND ITS SIGNIFICANCE IN MEDICINE

Diana Dzidziguri
Department of Biology, Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

Recent advances in biology and medicine demonstrate that gene expression does not cease immediately at biological death. Research on mouse (*Mus musculus*) and zebrafish (*Danio rerio*) models conducted by Peter Noble and Alex Pozhitkov (2016–2017) revealed an increase in the activity of over 1,000 postmortem genes within 24 to 48 hours following death. Termed "zombie genes," these active genes and the synthesized messenger RNA (mRNA) form the thanatotranscriptome, proving that postmortem tissue remains transcriptionally dynamic.

As cellular regulatory mechanisms collapse, suppressed genes lose their constraints, resulting in peak activity during the postmortem interval (PMI). Five distinct functional categories have been identified:

- Embryonic Development Genes: Silenced postnatally, these reactivate postmortem.
- Oncogenes: Suppressed during life to prevent uncontrolled growth, these escape regulation after death.
- Stress and Immune Response Genes: Activated as cells attempt self-preservation (*autoresuscitation*) under extreme hypoxia.
- Apoptosis Genes: Regulate programmed cell death and cellular fragmentation.
- Epigenetic Modifiers: Facilitate nucleosome unwinding and DNA decondensation, triggering a cascade of sequential gene expression.

Additionally, human tissue data from the Genotype-Tissue Expression (GTEx) project highlights the heterogeneous, time-specific postmortem activation of homeobox (HOX) family genes, as well as specific liver biomarkers such as AMBP and AHSG.

Because postmortem genes activate and degrade along distinct temporal trajectories across different tissues, their transcriptomic profiles function as precision "molecular clocks." Analyzing the thanatotranscriptome allows forensic investigators to determine the post-mortem interval (PMI) with hourly precision.

During clinical death, cellular defense mechanisms temporarily preserve tissue viability. Deciphering these pathway dynamics provides practical strategies to:

- Protect the brain and vital organs from ischemic and hypoxic damage during resuscitation.
- Extend the cold/warm ischemia preservation windows for transplantable organs without requiring invasive genetic modifications.

Death is a gradual, systemic cascade rather than an instantaneous shutdown. The thanatotranscriptome demonstrates that cellular machinery continues to struggle for survival, offering critical diagnostic tools for forensic science and therapeutic strategies for regenerative and transplant medicine.

Keywords: Thanatotranscriptome, Postmortem Gene Expression, Zombie Genes, Post-Mortem Interval (PMI), Forensics, Organ Transplantation, Hypoxia, GTEx Project.