The Epigenetics of Trauma: Implications Across Populations

Becky Austin-Morris, DNP, PMHNP-BC
Director of Behavioral Health & Foster Care

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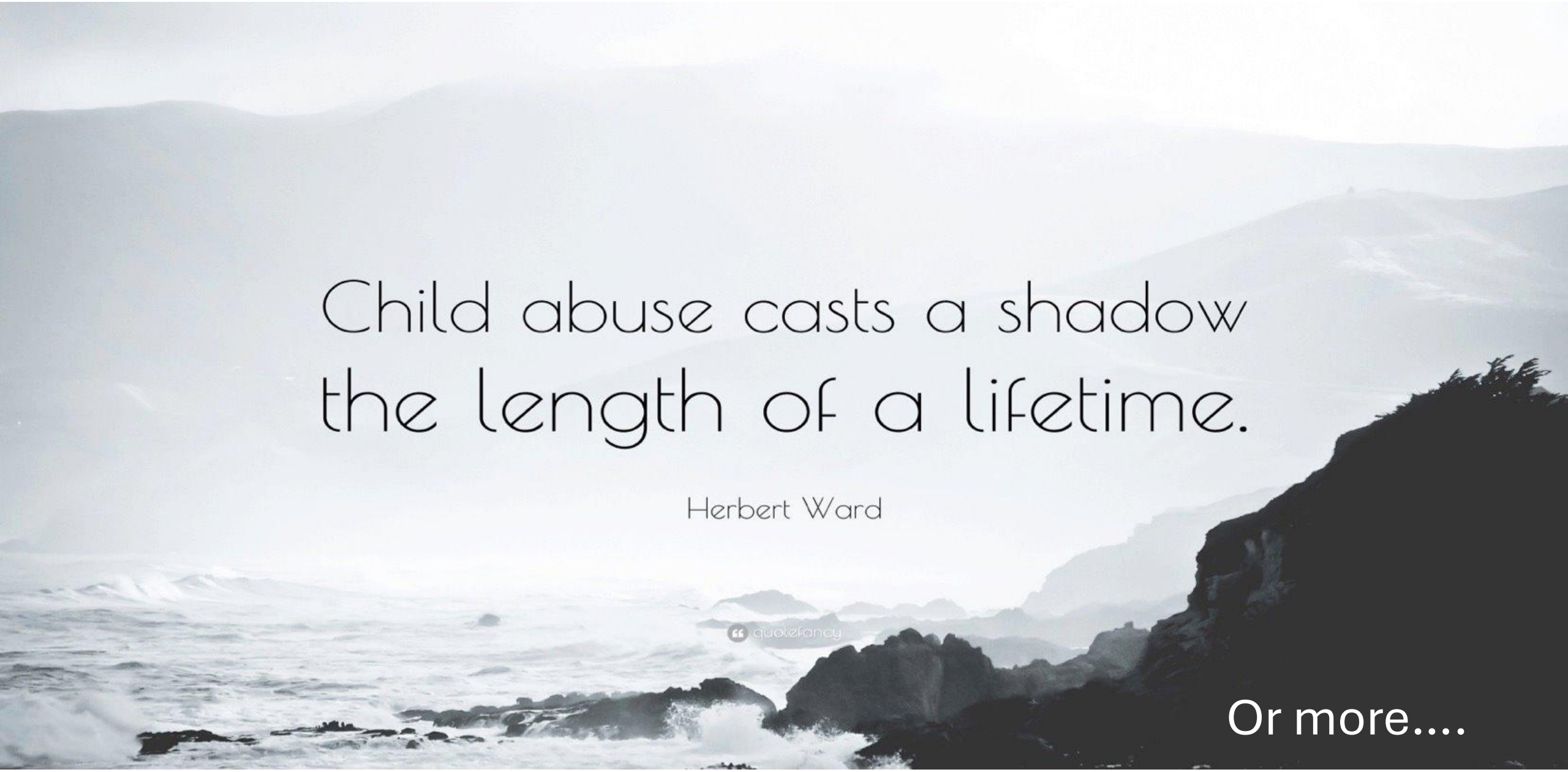

Child abuse casts a shadow
the length of a lifetime.
Herbert Ward
quotefancy

Or more....

Learning Objective

- By the end of this session, participants will be able to describe how traumatic experiences may influence gene expression and long-term health outcomes through epigenetic mechanisms, and identify trauma-informed, resilience-focused implications for care across populations.

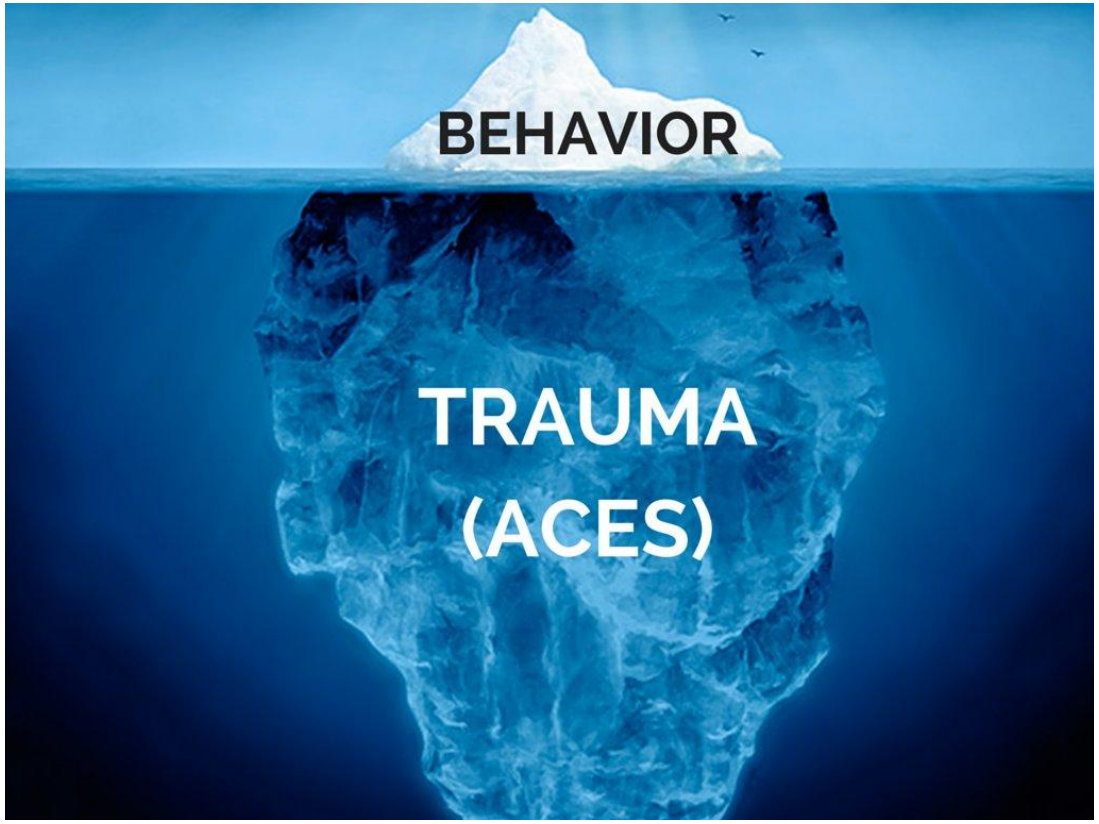
Why This Matters…

- FFY 2023: 3.08 million children received a CPS investigation or alternative response; 546,159 children were confirmed victims of abuse or neglect.
- Adverse Childhood Experiences (ACE) are potentially traumatic experiences before age 18 that can undermine safety, stability, bonding, and lifelong health.
- Toxic stress is prolonged activation of the biological stress response without adequate buffering relationships or supports.
- 2026 practice emphasis: pair trauma-informed awareness with relational care, symptom assessment, SDOH/resource assessment, and warm handoffs.

ACE Study: Foundational Public Health Evidence

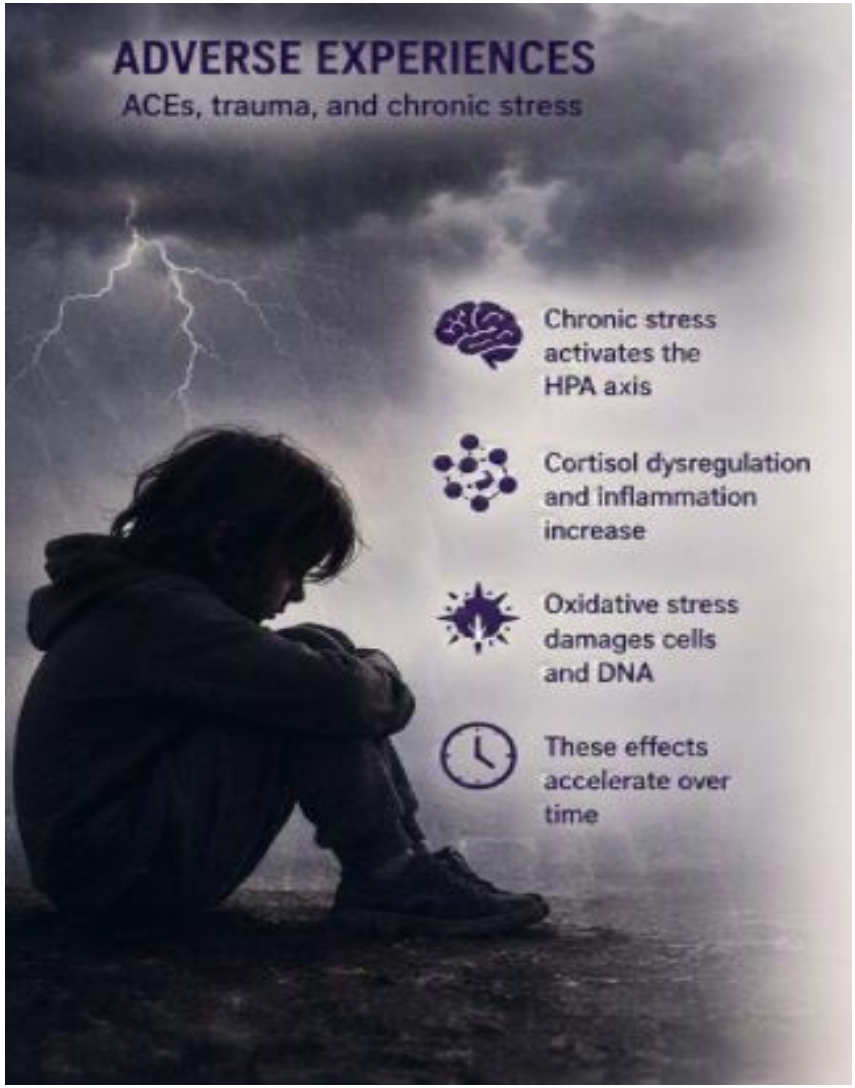
The original CDC-Kaiser ACE Study linked childhood adversity with increased risk for long-term behavioral, physical, and social health outcomes. ACEs are exposures; toxic stress is the biological stress-response pattern that may occur when adversity is prolonged and not buffered by supportive relationships.

ACES Influence What We See – and What We May Not See



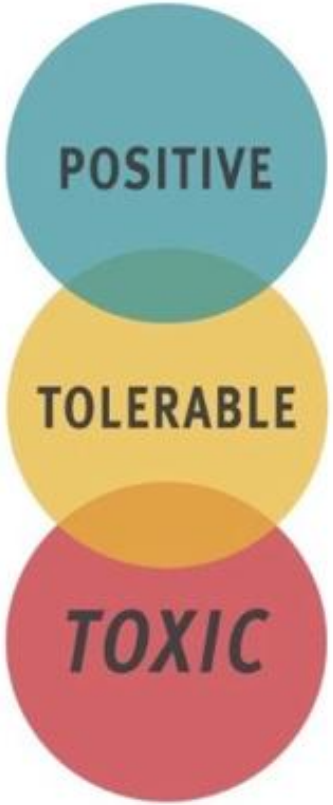
- ACEs are a major driver of population health, health equity, and social well-being.
- Risk is cumulative, but outcomes are not predetermined; protective relationships and timely supports buffer risk.
- Current ACE/PCE work also considers bullying, homelessness, foster care involvement, serious illness/injury, historical trauma, community violence, and food/housing insecurity.
- Shift the frame: from “What is wrong?” to “What happened, what strengths exist, and what support is needed now?”

From Adversity to Biological Embedding



sunflower health plan

Positive, Tolerable & Toxic Stress



- Brief increases in heart rate, mild elevations in stress hormone levels.
- Serious, temporary stress responses, buffered by supportive relationships.
- Prolonged activation of stress response systems in the absence of protective relationships.

Kansas Childhood Adverse Childhood Experiences (ACEs)

2022–2023

Prevalence snapshot for education and population-health planning

39.8%

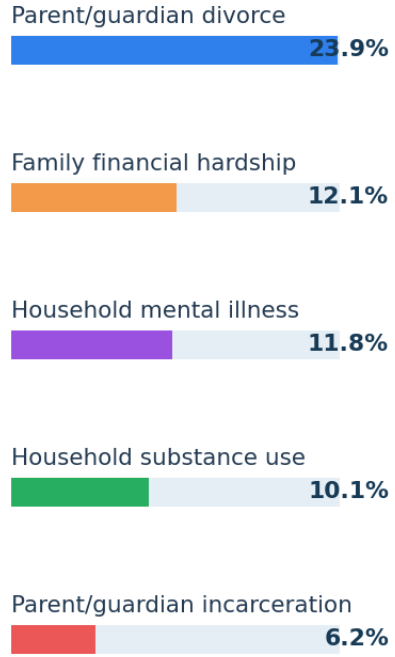
Kansas children with 1+ ACEs

20.6%

Kansas children with 2+ ACEs

Top reported ACEs

Kansas children, 2022–2023



Key message: Nearly 2 in 5 Kansas children have experienced at least one ACE — prevention, early support, and safe, stable, nurturing relationships matter.

Source: KDHE Special Emphasis Report: Adverse Childhood Experiences (ACEs), 2025; National Survey of Children's Health, 2022–2023.

Kansas Statewide Relevance

- Trauma impacts children and families across rural, urban, frontier, and suburban communities in **all 105 Kansas counties**.
- Emerging epigenetic research suggests that **chronic adversity may influence stress-response, neurodevelopmental, immune, and lifelong health pathways**—while resilience and supportive relationships can help mitigate these effects.
- Kansas opportunities include strengthening trauma-informed care, early intervention, behavioral health access, family supports, and Positive Childhood Experiences (PCEs) to promote resilience and improve outcomes.
- Measure what matters: access to care, successful referrals, family engagement, positive childhood experiences, resilience, and improved health outcomes.

Bottom Line:
Nearly 2 in 5 Kansas children have experienced at least one ACE, highlighting the importance of statewide prevention, early intervention, and relationship-centered approaches to healing and resilience.

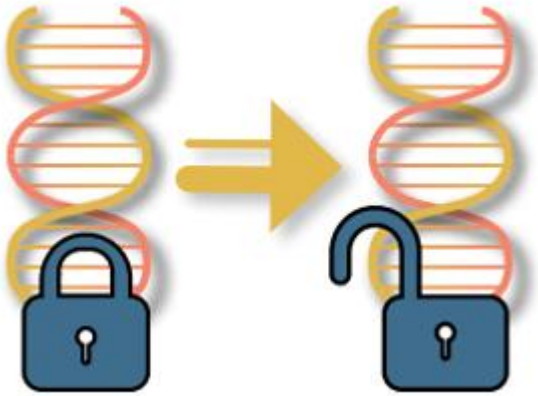
Economics

- FFY 2023 national child maltreatment data: 546,159 confirmed victims and an estimated 2,000 child deaths from abuse or neglect.
- The economic impact is substantial across:
  - Health care
  - Behavioral health
  - Child welfare
  - Education
  - Workforce
  - Justice systems
- A 2023 JAMA Network Open study estimated the annual economic burden of ACE-associated adult health conditions at more than $14 trillion.
- Prevention and early intervention should be framed as quality, equity, and fiscal stewardship—not only as clinical best practice.

What is EPIGENETICS?

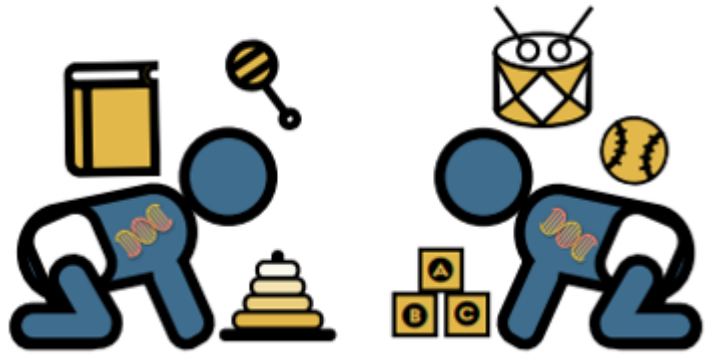
And How Does It Relate to Child Development?

Epigenetics” is an emerging area of scientific research that shows how environmental influences—children’s experiences—actually affect the expression of their genes.

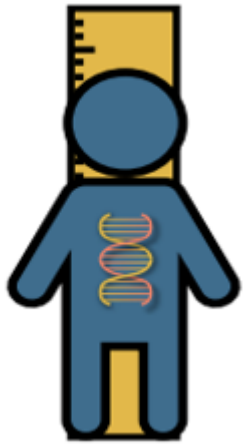


During development, the DNA that makes up our genes accumulates chemical marks that determine how much or little of the genes is expressed. This collection of chemical marks is known as the “epigenome.” The different experiences children have rearrange those chemical marks. This explains why genetically identical twins can exhibit different behaviors, skills, health, and achievement.

This means the old idea that genes are “set in stone” has been disproven. Nature vs. Nurture is no longer a debate. It’s nearly always both!



EPIGENETICS: How Early Experiences can have Life-Long Impacts



The genes children inherit from their biological parents provide information that guides their development. For example, how tall they could eventually become or the kind of temperament they could have.

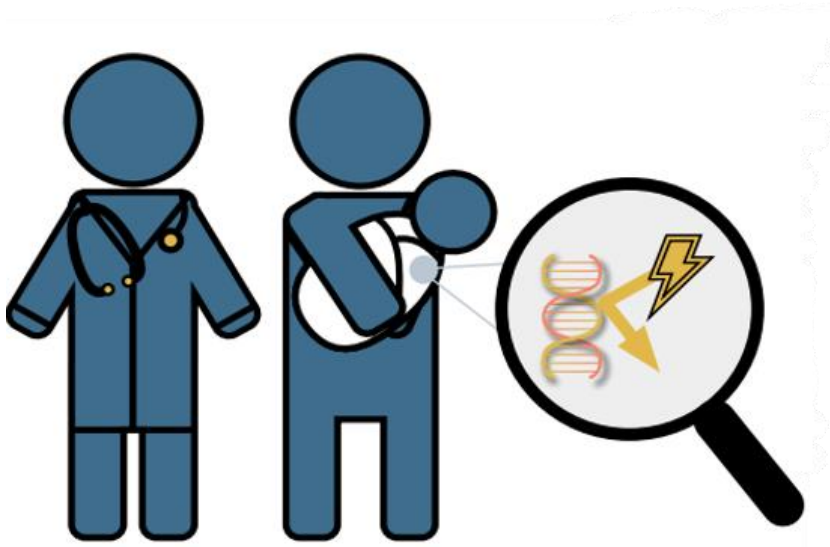
When experiences during development rearrange the epigenetic marks that govern gene expression, they can change whether and how genes release the information they carry.

Thus, the epigenome can be affected by positive experiences, such as supportive relationships and opportunities for learning…

… or negative influences, such as environmental toxins or stressful life circumstances …

Young Brains are Particularly Sensitive to EPIGENETIC Changes

Experiences very early in life, when the brain is developing most rapidly, cause epigenetic adaptations that influence whether, when, and how genes release their instructions for building future capacity for health, skills, and resilience. That's why it's crucial to provide supportive and nurturing experiences for young children in the earliest years.

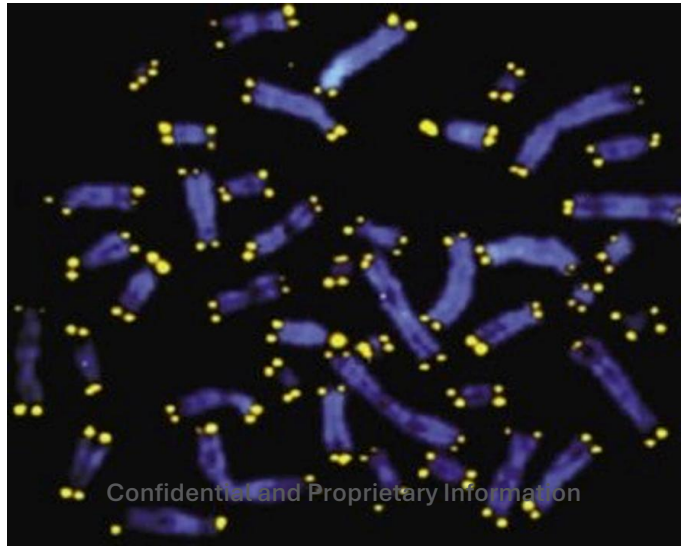


Services such as high-quality health care for all pregnant women, infants, and toddlers, as well as support for new parents and caregivers can—quite literally—affect the chemistry around children's genes. Supportive relationships and rich learning experiences generate positive epigenetic signatures that activate genetic potential.

Center on the Developing Child | HARVARD UNIVERSITY
For more information:
https://developingchild.harvard.edu/epigenetics/

Trauma → Epigenetic Changes → Shorter Telomeres → Health Effects

- What are Telomeres?
  - Telomeres are protective caps at the ends of chromosomes.
  - Telomeres naturally shorten with age.
  - Chronic stress, inflammation, and oxidative stress may accelerate telomere shortening.
  - Shorter telomeres are one marker associated with biological aging.



How Trauma Affects Telomeres

Trauma activates the body's stress-response systems:

1. Chronic cortisol exposure
   - Persistent activation of the HPA axis increases cortisol levels.
   - High cortisol can promote cellular aging and reduce telomerase activity (the enzyme that helps maintain telomeres).
2. Inflammation
   - Trauma is associated with elevated inflammatory markers.
   - Chronic inflammation increases oxidative stress, damaging cells and accelerating telomere shortening.
3. Oxidative stress
   - Excess free radicals damage DNA and telomeres.
   - Telomeres are particularly vulnerable to oxidative injury.

Common Trauma-Associated Biomarkers

Marker	Trauma Effect	Potential Impact
Telomere Length	Shorter	Accelerated biological aging
Cortisol	Dysregulated (high or low)	Chronic stress response
CRP (C-reactive protein)	Increased	Systemic inflammation
IL-6	Increased	Pro-inflammatory cytokine
TNF-α	Increased	Chronic inflammation
FKBP5 Gene Expression	Altered	Stress regulation changes
NR3C1 (Glucocorticoid Receptor) Methylation	Altered	HPA-axis dysfunction
BDNF	Reduced	Impacts learning, memory, resilience

2026 Guardrails: What Epigenetic Findings Do — and Do Not — Mean

What the science supports

Trauma and toxic stress can become biologically embedded.

Patterns are most useful for population-health understanding and prevention strategy.

Clinical response should focus on safety, symptoms, functioning, strengths, and support needs.

Biology is plastic; healing environments matter.

What to avoid

Do not imply trauma permanently damages a child.

Do not use epigenetic markers as a stand-alone clinical test or risk label.

Do not confuse association with individual prediction.

Do not separate biology from social, relational, and structural context.

Sources: AAP Pediatrics 2024 ACE screening appraisal; JAMA Network Open 2024; Frontiers in Psychiatry 2026.

Clinical and System Implications

The response must be trauma-informed, relationship-centered, and operationally clear.

Universal trauma-informed approach: assume trauma may be present and create safe, predictable, choice-oriented care.

Relational health: identify trusted adults, support caregiver capacity, and build connection as intervention.

Clinical assessment: screen for symptoms and functioning—not just exposure history.

Social needs and safety: address food, housing, violence exposure, caregiver stress, and mandated reporting obligations.

Closed-loop referral: warm handoff, confirm linkage, document outcome, and reassess.

Bottom line: Epigenetics strengthens the case for early prevention, concrete supports, and healing relationships.

Sources: AAP Pediatrics 2024; CDC ACEs Prevention Resource for Action; MDPI Children 2026.

Resilience Can Buffer Risk and Support Healing

Building Resilience

- At least one stable, caring, supportive relationship
- Safe, predictable environments
- Connection and belonging, skill-building and self-efficacy
- Access to concrete supports
- Opportunities to ask for help and be heard

Conclusion

- Prevention and early support remain key.
- Toxic stress is cumulative, but outcomes are not fixed when protective relationships and supports are present.
- Early adversity can influence health across the lifespan.
- Epigenetics helps explain how experience may become biologically embedded.
- ACE scores alone are not enough; assess symptoms, functioning, safety, strengths, and support needs.
- Outcomes are not fixed. Protective relationships and timely supports matter.
- The clinical standard is trauma-informed care, warm handoffs, and closed-loop follow-up.

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Questions