

Vestigial Anatomy in a Technologically Modified Selective Environment

A Reassessment of Transitional Structures in Human Evolution

Working Paper

Document ID	VA-TMSE-2026-001
Version	1.0
Date	2026-09-11
Author	Kevin Alexander
Status	Demo specimen — deliberately non-viable example for review-site demonstration
Purpose	Specimen paper for the Falsification Analytics review-site demo; reviewed in VABP-2026-001
Note	Text unchanged from source manuscript; presentation rebuild only

Version Notes

- v1.0 (2026-09-11) — Initial typeset release (house style): metadata table, version notes, versioned footer added. Specimen text unchanged.

Abstract

Vestigial anatomy is conventionally interpreted retrospectively. Structures displaying reduced ancestral function, variable expression, diminished mechanical importance, or apparent redundancy are generally understood as remnants of earlier adaptive

states. This interpretation is well supported in many cases, but it may be incomplete when applied to a species that increasingly constructs its own selective environment.

For much of the history of *Homo sapiens*, behavioral and technological innovations have progressively altered the relationship between biological capacity and environmental demand. Tools, controlled fire, food processing, shelter, clothing, agriculture, animal domestication, transportation, medicine, and industrial technology have each substituted cultural or technological solutions for functions that would otherwise depend more heavily upon biological performance. Gene–culture coevolution demonstrates that such environmental modification can generate or modify selection pressures affecting subsequent human evolution.

This paper proposes that some anatomical structures currently described as vestigial, rudimentary, or highly variable may therefore be interpreted not exclusively as remnants of past adaptation but as transitional structures within an ongoing process of human adaptation to a technologically modified selective environment. The hypothesis does not require evolutionary anticipation or direction toward predetermined biological outcomes. Rather, it treats technological development as an existing environmental condition capable of altering the costs, benefits, and constraints associated with maintaining particular anatomical structures.

Evidence from gene–culture coevolution, changing human skeletal morphology, dental variation, and variable musculature supports the broader proposition that human biology remains responsive to culturally modified environments. However, direct reconstruction of long-term anatomical change is uneven because skeletal and dental tissues dominate the archaeological record while many soft-tissue structures leave little recoverable evidence.

A transitional interpretation of vestigial anatomy may therefore provide a useful framework for investigating whether some apparently declining, variable, or repurposed structures represent ongoing evolutionary responses rather than completed remnants of evolutionary history.

Keywords: vestigial anatomy; human evolution; niche construction; gene–culture coevolution; technological adaptation; anatomical variation; evolutionary transition

1. Introduction

The human body contains numerous anatomical structures that have historically been described as vestigial. The term has often been understood popularly to mean useless, but evolutionary vestigiality does not require complete loss of function. A structure may retain secondary or reduced functions while having lost much of the ancestral role associated with its earlier form.

This distinction is important because evolutionary change rarely produces a simple boundary between functional and nonfunctional anatomy. Structures may decline, persist, vary among individuals, acquire secondary functions, or become incorporated into new functional relationships.

The human vermiform appendix provides a familiar example. Historically characterized as a digestive remnant, the appendix is now recognized as containing substantial lymphoid tissue and may contribute to gastrointestinal immune and microbial processes. Its retained functions do not necessarily erase its evolutionary history, but they demonstrate that the categories “functional” and “vestigial” need not be mutually exclusive.

Human musculature provides similar ambiguity. The palmaris longus is absent in substantial portions of some populations without obvious impairment of ordinary hand function. The plantaris muscle has likewise been characterized historically as vestigial or functionally minor, yet recent anatomical research has proposed that it may retain or be acquiring sensorimotor significance. Other variable muscles of the upper extremity have also been discussed as possible examples of ongoing evolutionary change.

These observations raise a broader question.

When an anatomical structure is reduced, variable, dispensable, or functionally altered, how confidently can its evolutionary status be classified as exclusively retrospective?

The question is particularly relevant to humans because human evolution occurs within an unusual environmental context. Humans do not merely adapt biologically to external environments. Through culture and technology, they extensively reconstruct those environments.

The selective environment inhabited by modern humans is consequently not independent of human behavior. Food is processed before ingestion. Temperature is regulated by clothing, shelter, heating, and cooling. Physical work is transferred to tools, animals, engines, and machines. Transportation reduces locomotor demands. Medicine alters survival outcomes. Agriculture changes diet and pathogen exposure. Social systems distribute resources and support individuals who might otherwise face different survival pressures.

Human biology therefore exists within an environment that is increasingly partly manufactured by human behavior itself.

The central hypothesis examined here is that this process may influence how some forms of vestigial anatomy should be interpreted. Rather than representing exclusively the diminishing remains of adaptations belonging to earlier environments, some such structures may occupy intermediate states within ongoing anatomical responses to technologically mediated changes in selective pressure.

This hypothesis does not imply that evolution predicts future technological needs. It instead proposes that technological modification of the human environment has already occurred and that biological populations may consequently respond to those altered conditions.

The distinction is essential. The proposed model is not teleological. It does not suggest that anatomical structures are developing in preparation for future environments. It asks whether structures observed in the present may reflect biological responses to environmental transformations that have already begun.

2. Vestigiality as an Evolutionary Category

Vestigiality is fundamentally comparative.

An anatomical structure becomes recognizable as vestigial through comparison with ancestral states, homologous structures in related species, developmental patterns, functional requirements, or variation within a population. A reduced structure may retain some function while nevertheless differing substantially from the role or importance of its ancestral counterpart.

This creates an interpretive difficulty.

Evolutionary classification usually proceeds retrospectively because ancestral comparisons provide evidence that can already be examined. If a structure was larger, more consistent, or more functionally important in ancestral populations, its reduced modern state can reasonably be interpreted as the consequence of past evolutionary change.

The same present-day anatomy, however, can potentially occupy more than one temporal position.

A reduced structure may be:

- the stable endpoint of an earlier reduction;
- a structure continuing to undergo reduction;
- a structure maintained because of a secondary function;
- a structure subject primarily to weak selection or genetic drift;
- a structure undergoing functional repurposing;
- or a transient anatomical state whose eventual distribution cannot yet be observed.

These categories are not necessarily distinguishable from morphology alone.

The plantaris muscle illustrates the difficulty. Historically regarded as a regressing or vestigial muscle, it displays substantial anatomical variation and may be absent in some individuals. Recent work has challenged the simple regression interpretation by proposing that its morphology and proprioceptive characteristics are compatible with functional repurposing toward a sensorimotor role.

Likewise, the palmaris longus displays striking variation in presence among human populations. Its absence generally produces little obvious functional impairment, and the tendon is commonly harvested for reconstructive surgery. Such characteristics are compatible with reduced functional dependence, but the evolutionary trajectory represented by the observed variation is not directly visible.

Anatomy provides a present state.

Evolutionary interpretation attempts to reconstruct the trajectory producing it.

The distinction becomes particularly important when environmental conditions themselves are changing rapidly.

3. Human Technological Niche Construction

The earliest known members of the *Homo sapiens* lineage extend to approximately 300,000 years ago. The Jebel Irhoud fossils from Morocco, dated to approximately 315,000 years ago, demonstrate that important components of early *H. sapiens* morphology were present by the Middle Pleistocene.

Technology, however, did not begin with *Homo sapiens*. Stone-tool traditions substantially predate our species. The relevant development is therefore not the invention of technology at the emergence of modern humans, but the increasingly cumulative relationship between technology, culture, and human environmental modification during our subsequent history.

Niche-construction theory provides an established framework for understanding this relationship. Organisms can modify features of their environments in ways that alter selection pressures acting upon themselves and other organisms. Humans are especially powerful niche constructors because environmental modifications can be culturally transmitted across generations.

Dairying and lactase persistence provide a well-studied example.

In most mammals, lactase production declines after weaning. In several human populations with histories of pastoralism and milk consumption, genetic variants supporting continued lactase production became common. Cultural behavior—in this case animal domestication, dairying, and milk consumption—changed the nutritional environment. That altered environment subsequently affected the relative fitness associated with particular genetic variants.

The importance of this example extends beyond milk digestion.

It demonstrates that human cultural behavior can precede biological adaptation and contribute to the selection pressure producing it.

The causal direction need not therefore be:

environment → biological adaptation → behavior

It may also include:

behavior → modified environment → altered selection pressure → biological adaptation

Once this relationship is accepted, technology becomes evolutionarily relevant whenever it persistently changes the costs or benefits associated with biological traits.

4. From Biological Performance to Technological Substitution

Human technological history can be viewed partly as a progressive transfer of environmental demands from biological systems to external systems.

- A stone cutting tool substitutes for anatomical cutting ability.
- Controlled fire and food processing reduce some mechanical and digestive demands associated with consuming raw foods.
- Clothing and shelter supplement biological thermoregulation.
- Agriculture changes the composition, reliability, and distribution of food resources.
- Animal domestication changes nutrition, mobility, disease exposure, and labor.
- Mechanical systems multiply muscular output.
- Transportation reduces the biological cost of moving people and materials.
- Corrective lenses compensate for visual limitations.
- Dentistry preserves or substitutes dental function.
- Antibiotics, surgery, vaccination, and other medical technologies alter mortality and reproductive outcomes associated with conditions that historically operated under different constraints.
- Modern heating and air conditioning further reduce direct exposure to climatic extremes.

None of these innovations removes natural selection. Instead, they alter the environment in which selection occurs.

The resulting selective landscape may contain both new pressures and relaxed old pressures.

This distinction is important. Technological development should not be understood simply as weakening evolution. A constructed environment can reduce the fitness consequences of one trait while increasing those associated with another. Agriculture, for example, produced new dietary opportunities while also increasing population density and exposure to infectious disease. Dairying created a new nutritional resource while favoring biological adaptations permitting its efficient use.

Technology therefore does not stop biological evolution.

It changes its context.

5. Evidence of Biological Change in Culturally Modified Environments

The lactase-persistence example establishes that culturally generated environmental change can influence human genetic evolution. Other evidence indicates that human morphology also responds to changing behavior and subsistence.

Changes in mobility associated with the transition toward agriculture have been linked with changes in skeletal robusticity. Human bone responds developmentally to mechanical loading, while longer-term population differences may reflect interactions among behavior, development, genetics, nutrition, and demography.

Dental and craniofacial morphology provide another area in which changing dietary and mechanical environments are relevant. Cooking, grinding, cutting, and other forms of food processing reduce the mechanical requirements of mastication relative to many unprocessed diets.

Third molars are particularly interesting because agenesis is common and highly variable among modern populations. Their frequent absence demonstrates that a component of the standard human dentition can fail to develop in a substantial proportion of otherwise healthy individuals.

This does not by itself demonstrate technologically driven evolutionary reduction. Development, population history, genetics, and other variables must be considered. It does, however, illustrate a central characteristic relevant to transitional anatomy: substantial variation in the presence of a structure can exist without preventing normal survival and reproduction in modern environments.

Variable musculature provides another example.

The palmaris longus can be absent without substantial loss of ordinary wrist function. Several muscles of the distal upper extremity display anatomical variability sufficient to have prompted hypotheses that ongoing evolutionary changes may be occurring in this region.

The significance of these examples is not that each can be directly attributed to technology.

Rather, they establish three narrower propositions:

- First, human anatomy remains variable.

- Second, some anatomical structures can be reduced or absent without substantial functional consequences under current conditions.
- Third, culturally modified environments are capable of altering selection pressures.

Together, these propositions justify examining whether the conventional retrospective interpretation of vestigial anatomy captures every relevant evolutionary possibility.

6. The Transitional-Structure Model

This paper proposes the term transitional structure for an anatomical feature whose present morphology may reflect an unresolved evolutionary response to altered selective conditions.

A transitional structure need not be newly evolved. Indeed, it may be evolutionarily ancient.

What makes it transitional is not its age but the possibility that its current relationship to fitness has changed and that its population distribution, morphology, or function has not reached a stable evolutionary condition.

Under this model, a structure formerly important under one environmental regime may experience reduced selection after technological substitution diminishes its functional importance.

Several outcomes could follow.

- The structure might progressively decline in prevalence.
- Its morphology might become increasingly variable.
- It might persist because the metabolic or developmental cost of maintaining it is insufficient to generate strong selection against it.
- It might retain a secondary function.
- It might become integrated into another functional system.
- It might be repurposed through subsequent selection.
- Or it might remain anatomically stable despite reduced importance.

These possibilities complicate the conventional image of vestigiality as a one-directional process of progressive disappearance.

A structure can lose one function without disappearing.

It can also become evolutionarily available for another.

The proposed model therefore interprets vestigiality as potentially describing a state within an evolutionary trajectory, rather than necessarily identifying the terminal state of that trajectory.

7. Candidate Anatomical Structures

7.1 The Vermiform Appendix

The appendix demonstrates why functional status alone cannot determine vestigial status.

Its historical association with a larger digestive cecum encouraged its interpretation as an evolutionary remnant. Subsequent research has identified substantial lymphoid tissue and proposed roles involving intestinal microbial ecology and immune function.

This does not require rejection of its evolutionary history. Instead, the appendix may illustrate how an anatomical structure can persist after alteration of an ancestral function while retaining or developing another biological role.

Within the transitional-structure model, the appendix is therefore significant not because it proves technologically mediated evolution but because it demonstrates that reduction of an ancestral role does not dictate the subsequent evolutionary fate of a structure.

7.2 Palmaris Longus

The palmaris longus presents a different pattern.

It is highly variable and can be congenitally absent without major impairment of ordinary hand function. Its tendon can be harvested surgically for reconstruction elsewhere in the body, further demonstrating its limited necessity for normal function in many individuals.

Such a structure provides a useful model for relaxed functional dependence.

If environmental or behavioral changes reduce the reproductive consequences associated with maintaining a structure, variation may accumulate without producing strong fitness differences.

Whether palmaris longus prevalence is actively declining remains a separate empirical question. Its current variability nevertheless demonstrates the type of anatomical condition expected when a structure is not uniformly required.

7.3 Plantaris

The plantaris is particularly informative because recent interpretations challenge its classification as a simple regressing remnant.

Its variable morphology and limited contribution to gross mechanical force historically supported descriptions of vestigiality. However, evidence concerning proprioceptive fibers and anatomical organization has led to proposals that the structure may have sensorimotor significance and may represent functional repurposing.

If confirmed, this would illustrate an important principle of the transitional model: loss or reduction of an ancestral function does not restrict a structure to eventual disappearance.

Evolution can reuse existing anatomy.

7.4 Third Molars

Third molars offer a different form of variation because their complete developmental absence is common. Global estimates indicate agenesis of at least one third molar in roughly one quarter of modern humans, although frequencies vary considerably among populations.

Modern food processing and reduced masticatory demands have frequently been discussed in relation to changes in human craniofacial development and dental problems. However, simple causal claims linking technological development directly to third-molar agenesis would exceed the evidence.

Their relevance here is narrower.

Third molars demonstrate that a standard anatomical feature can become highly variable in presence while its absence is broadly compatible with ordinary life in a technologically modified environment.

That makes them useful for considering how relaxed functional requirements may interact with developmental and genetic variation over evolutionary time.

8. Preservation and the Problem of Deep-Time Anatomy

Testing long-term anatomical hypotheses in humans faces an uneven evidentiary record.

Bones and teeth preserve relatively well and consequently dominate reconstructions of ancient morphology. Genetic material can sometimes provide additional evidence, particularly for more recent populations and favorable preservation environments.

Soft tissues present a much greater problem.

Mummification can preserve organs and other tissues under exceptional circumstances, but available specimens represent a tiny, geographically and temporally biased sample of past human populations. Even within preserved individuals, different tissues survive with dramatically different quality.

This creates an important asymmetry.

Evolutionary changes affecting skeletal anatomy may leave measurable sequences in the archaeological record.

Comparable changes affecting a small muscle, intestinal structure, ligament, vascular feature, or other soft tissue may leave little or no direct record.

The absence of a recoverable morphological sequence therefore cannot necessarily establish anatomical stability.

For many structures, the relevant sequence may simply be unavailable.

This limitation becomes increasingly severe across the approximately 300,000-year history of *Homo sapiens*. Exceptional preservation provides snapshots rather than continuous population-level records.

Consequently, the evolutionary history of many soft-tissue structures must be reconstructed indirectly through comparative anatomy, developmental biology, population variation, genetics, and functional analysis.

9. Competing Explanations

Any transitional interpretation of vestigial anatomy must coexist with several established evolutionary mechanisms.

Relaxed Selection

Reduced functional importance may weaken selection maintaining a structure. Variation can then accumulate without requiring directional selection toward a particular anatomical endpoint.

The transitional model is compatible with this mechanism. Indeed, relaxed selection may represent one pathway by which a previously constrained structure enters a more variable evolutionary state.

Genetic Drift

Changes in anatomical prevalence may occur through stochastic changes in allele frequencies, particularly when differences have little effect on reproductive success.

Drift therefore prevents anatomical reduction or increasing absence from being treated automatically as evidence of adaptation.

However, drift does not exclude the possibility that the selective environment surrounding the structure has changed. A technologically modified environment may reduce the fitness consequences associated with variation and thereby increase the relative importance of stochastic processes.

Developmental Constraint

An anatomical structure may persist because it is developmentally linked to other structures or because eliminating it would require changes with unfavorable consequences elsewhere.

Persistence therefore does not necessarily indicate continued adaptive importance.

At the same time, developmental persistence does not demonstrate evolutionary stability. A structure can remain present while its functional relationship to the organism changes.

Retained Secondary Function

A structure may continue to perform a function despite substantial reduction of its ancestral role.

The appendix provides a useful example.

Such secondary functionality complicates attempts to place anatomy into binary categories of useful versus vestigial. Retention may represent evolutionary continuity, functional repurposing, or both.

Exaptation and Functional Repurposing

Existing structures may acquire functions different from those associated with their original evolutionary development.

This possibility is especially important because it means that reduction of an ancestral function does not determine the future trajectory of the structure.

A structure released from one set of functional constraints may become available for another.

The transitional model therefore does not predict that all vestigial structures will disappear. It predicts instead that structures experiencing altered relationships between function and fitness may follow multiple trajectories.

10. A Technologically Modified Selective Environment

The defining feature of the proposed model is not anatomical reduction itself.

It is the environmental context in which reduction, persistence, variability, and repurposing occur.

Human technology increasingly separates biological performance from environmental outcome.

- A person does not require exceptional cold tolerance to survive a northern winter inside a heated structure.
- Reduced visual acuity can be compensated by corrective lenses.
- Dental damage can be repaired or replaced.
- Infection can be treated pharmacologically.
- Physical strength can be supplemented by machinery.
- Food can be mechanically and thermally processed before consumption.
- Transportation can replace long-distance locomotion.

These interventions vary enormously in age, distribution, and evolutionary significance. Modern medicine cannot reasonably explain anatomical changes occurring hundreds of thousands of years ago, and industrial technology has existed for only a tiny fraction of *Homo sapiens* history.

The technologically modified environment must therefore be understood as cumulative but heterogeneous.

Different technologies appeared at different times.

Different populations encountered different selective environments.

Some changes persisted for thousands of generations; others have existed for only a few.

The model consequently predicts no single uniform anatomical response.

Instead, technological niche construction should produce a mosaic of changing selective relationships, some ancient and widespread, others recent and population-specific.

Vestigial and highly variable structures may represent one anatomical record of this continuing process.

11. Discussion

The conventional interpretation of vestigial structures is strongly retrospective. Reduced or altered anatomy is compared with ancestral states and interpreted as evidence of functions that have diminished during evolutionary history.

Nothing in the present hypothesis requires rejecting that interpretation.

The question is whether retrospective explanation is sufficient.

Humans have progressively modified their selective environments through culturally transmitted behavior and technology. Gene–culture coevolution demonstrates that these modifications can produce measurable biological consequences. Human anatomy remains variable, and some structures display combinations of reduced necessity, inconsistent presence, secondary function, and possible functional repurposing.

It is therefore reasonable to consider whether at least some structures described as vestigial occupy transitional positions within continuing evolutionary processes.

The temporal orientation of the interpretation matters.

A structure may simultaneously contain evidence of where a species has been and evidence of an evolutionary process that has not reached an observable endpoint.

This does not mean that anatomy predicts the future.

Rather, current anatomy records biological responses to conditions extending from the past into the present. Where those conditions continue to change, the associated evolutionary trajectory may likewise remain unresolved.

The technologically modified human environment intensifies this problem because cultural change can occur much faster than genetic evolution.

Agriculture transformed human subsistence within a small fraction of the existence of *Homo sapiens*. Industrialization is more recent still. Modern medicine, mechanized transportation, climate-controlled buildings, and digital technology occupy only an instant on an evolutionary timescale.

Consequently, modern humans may inhabit environmental conditions to which biological evolution has had relatively little time to respond.

Structures that appear redundant today may therefore be observed during the early stages of altered selective relationships rather than at their evolutionary endpoints.

The model also accommodates the possibility that no simple endpoint exists.

- A structure experiencing relaxed selection may persist indefinitely.
- Another may decline in frequency.
- Another may become developmentally integrated elsewhere.
- Another may acquire a secondary function.
- Another may disappear.

The important commonality is that technological substitution can alter the selective environment in which these outcomes occur.

Present anatomical variation may consequently contain information about evolutionary processes still underway.

12. Evidentiary Limitations and Future Research

The transitional-structure hypothesis faces substantial empirical limitations.

- First, correlation between technological change and anatomical variation cannot by itself establish causation. Human populations differ genetically, environmentally, behaviorally, nutritionally, and demographically. Any proposed association must therefore distinguish technological selection pressures from

population history, drift, developmental plasticity, and other environmental variables.

- Second, many candidate structures lack sufficiently deep longitudinal records. Skeletal and dental features provide stronger opportunities for historical comparison than soft-tissue structures.
- Third, modern technology has existed for too few generations to support strong claims about long-term evolutionary outcomes. The most dramatic technological changes may therefore have evolutionary consequences that remain biologically unresolved.
- Fourth, vestigial structures should not be treated as a unified biological category. The appendix, plantaris, palmaris longus, third molars, and other commonly discussed examples have different developmental histories, functions, genetic architectures, and evolutionary backgrounds.

Future research should therefore evaluate structures independently.

- Population-level studies could examine whether anatomical presence, absence, morphology, or function correlates with historically persistent environmental and behavioral differences.
- Ancient DNA may permit reconstruction of allele-frequency changes associated with developmental pathways affecting particular structures.
- Skeletal and dental collections may allow temporal comparisons where anatomical preservation is adequate.
- Comparative primate anatomy can help distinguish older phylogenetic reductions from changes more specific to recent human populations.
- Functional studies can determine whether structures described as rudimentary actually retain important biological roles.

As these datasets improve, some candidate structures may prove stable, some may prove primarily subject to drift or developmental constraint, and others may demonstrate directional or functional change.

The transitional model is intended to accommodate this heterogeneity rather than require a uniform evolutionary outcome.

13. Conclusion

Human evolution occurs within an environment increasingly modified by human behavior.

Tools, food processing, shelter, agriculture, animal domestication, medicine, mechanization, and other technologies have altered the relationship between biological capacity and environmental demand. Gene–culture coevolution demonstrates that such changes can influence subsequent human biological evolution.

Vestigial anatomy is generally interpreted as evidence of evolutionary history, and that interpretation remains valid. However, a structure's ancestral history does not necessarily establish its future evolutionary trajectory.

Some structures presently described as vestigial, rudimentary, highly variable, or functionally redundant may instead—or additionally—represent transitional anatomy within an ongoing response to altered selective conditions.

- Their persistence need not indicate evolutionary stability.
- Their reduction need not imply inevitable disappearance.
- Their variability may reflect relaxed functional constraint.
- Their retained functions may preserve them.
- Their altered functions may represent repurposing.
- And the technologically constructed environment may continue changing the selective relationships surrounding them.

The human body should therefore not be viewed solely as the endpoint of evolutionary history. It is also a population of anatomical states existing within an environmental transition that remains underway.

Vestigial structures may preserve evidence of the past.

Some may also represent biological processes whose outcomes have not yet occurred.

References

- Capdarest-Arest, N., Gonzalez, J. P., & Türker, T. (2014). Hypotheses for ongoing evolution of muscles of the upper extremity. *Medical Hypotheses*, 82(4), 452–456. doi:10.1016/j.mehy.2014.01.021.
- Gerbault, P., Liebert, A., Itan, Y., Powell, A., Currat, M., Burger, J., Swallow, D. M., & Thomas, M. G. (2011). Evolution of lactase persistence: An example of human niche construction. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366, 863–877. doi:10.1098/rstb.2010.0268.
- Grove, C., Peschel, O., & Nerlich, A. G. (2015). A systematic approach to the application of soft tissue histopathology in paleopathology. *BioMed Research International*, 2015, 631465. doi:10.1155/2015/631465.
- Kooij, I. A., Sahami, S., Meijer, S. L., Buskens, C. J., & te Velde, A. A. (2016). The immunology of the vermiform appendix: A review of the literature. *Clinical & Experimental Immunology*, 186(1), 1–9. doi:10.1111/cei.12821.
- Laland, K. N., Odling-Smee, J., & Myles, S. (2010). How culture shaped the human genome: Bringing genetics and the human sciences together. *Nature Reviews Genetics*, 11, 137–148. doi:10.1038/nrg2734.
- Richter, D., Grün, R., Joannes-Boyau, R., Steele, T. E., Amani, F., Rué, M., Fernandes, P., Raynal, J.-P., Geraads, D., Ben-Ncer, A., Hublin, J.-J., & McPherron, S. P. (2017). The age of the hominin fossils from Jebel Irhoud, Morocco, and the origins of the Middle Stone Age. *Nature*, 546, 293–296. doi:10.1038/nature22335.
- Smith, H. F. (2023). A review of the function and evolution of the cecal appendix. *The Anatomical Record*, 306(5), 972–982. doi:10.1002/ar.24917.
- Stringer, C., & Galway-Witham, J. (2017). On the origin of our species. *Nature*, 546, 212–214.
- Angelakopoulos, N., Boedi, R. M., Franco, A., Gkantidis, N., De Luca, S., & Pandis, N. (2026). Third molar agenesis: An updated systematic review and meta-analysis. *Archives of Oral Biology*, 189, 106662. doi:10.1016/j.archoralbio.2026.106662.
- The Plantaris Muscle Is Not Vestigial: Developmental, Comparative, and Functional Evidence for Its Sensorimotor Role. (2025). *Biology*, 14(6), 696.
-