

EVIDENCE OF MOLECULAR BIOLOGY, CYTOLOGY EMBRYOLOGY IN PROVING
EVOLUTION

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Abstract: *in this article you will find some information about integrating evidence from molecular biology, cytology, and embryology, scientists can construct a comprehensive understanding of evolutionary relationships and the processes that have shaped the diversity of life on Earth.*

Key words: *cytology, embryology, evolution, molecular level, DNA, teratology*

Molecular biology, cytology, and embryology play crucial roles in providing evidence for the theory of evolution. Here's how each of these fields contributes to our understanding of evolutionary processes:

Molecular Biology: Molecular biology is the study of biological processes at the molecular level, focusing on the structure and function of molecules such as DNA, RNA, and proteins. [1] It provides a powerful framework for understanding the mechanisms of life and has been instrumental in supporting the theory of evolution. Here are some key concepts in molecular biology that support the theory of evolution:

1. DNA and genetic evidence: The study of DNA and genetic material has provided strong evidence for common ancestry and evolution. Comparing the DNA sequences of different species has revealed similarities that support the idea of a shared evolutionary history. Molecular biology has revolutionized our understanding of genetics and heredity. The discovery of the structure of DNA by Watson and Crick in 1953 provided a foundation for understanding how genetic information is stored and transmitted from one generation to the next. Comparing the DNA sequences of different species has revealed striking similarities, providing evidence for common ancestry and evolutionary relationships.

2. Genetic mutations: Molecular biology has shown that genetic mutations can lead to changes in organisms over time. These mutations can be inherited and contribute to the diversity of life on Earth, supporting the concept of natural selection and adaptation.

3. Molecular clocks: Molecular biology has also led to the development of molecular clocks, which use genetic data to estimate the timing of evolutionary events. By comparing the differences in DNA sequences between species and using mutation rates as a "molecular clock," scientists can infer the timing of common ancestors and evolutionary divergences.[2]

4. Comparative genomics: The field of comparative genomics, made possible by advances in molecular biology, allows researchers to compare entire genomes across different species. This approach has revealed shared genetic elements and regulatory pathways among diverse organisms, providing evidence for common ancestry and

evolutionary relationships.[3] So, molecular biology has provided compelling evidence for the theory of evolution by revealing the genetic basis of inheritance, demonstrating the relatedness of all living organisms at the molecular level, and enabling researchers to trace evolutionary relationships through genetic data. The insights gained from molecular biology continue to deepen our understanding of evolutionary processes and the history of life on Earth.

Cytology: Cytology is the branch of biology that focuses on the study of cells, their structure, function, and behavior. It is a fundamental field within biology, as cells are the basic units of life and the building blocks of all living organisms. Cytologists investigate the various functions of cells, including metabolism, growth, division, and differentiation. They study how cells obtain and utilize energy, synthesize proteins and other molecules, respond to stimuli, and carry out specialized functions in different tissues and organs. Cytology explores how cells communicate with each other through signaling pathways, cell-to-cell interactions, and the exchange of molecular signals. This includes understanding how cells respond to extracellular cues and coordinate their activities within multicellular organisms. Cytologists study the processes of cell division, including mitosis and meiosis, as well as the regulation of the cell cycle. Understanding these processes is crucial for insights into growth, development, and the maintenance of genetic integrity in organisms. Cytology plays a critical role in understanding diseases at the cellular level. It involves the examination of abnormal cellular structures and functions to diagnose and understand various medical conditions, such as cancer, infectious diseases, and genetic disorders. Cytology encompasses a wide range of topics, from the structure and organization of cells to their physiological processes and interactions with their environment. Here are some key aspects of cytology:[4]

1. **Comparative cell biology:** Cytology involves the study of the structure and organization of cells, including their internal organelles, cytoskeleton, and cell membrane. This includes understanding the roles and functions of cellular components such as the nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, and other organelles. Cytology, the study of cells, has revealed striking similarities in the cellular structure and function of different organisms. This suggests a common evolutionary origin and supports the idea of a shared ancestry among living organisms.

2. **Endosymbiotic theory:** The study of cell organelles, such as mitochondria and chloroplasts, has provided evidence for the endosymbiotic theory, which proposes that these organelles were once free-living bacteria that were engulfed by ancestral eukaryotic cells. This theory supports the idea of evolutionary relationships between different groups of organisms.[6]

Embryology: Embryology is the branch of biology that focuses on the study of the development of embryos from the fertilization of the egg to the fetus stage. It encompasses the processes of fertilization, embryogenesis, and fetal development in various organisms, including humans and other animals. Embryology begins with the

process of fertilization, where a sperm cell fuses with an egg cell to form a zygote. This marks the initiation of embryonic development, and the zygote undergoes a series of cell divisions and differentiation to form an embryo. Embryology studies the early stages of development, including the formation of germ layers, the development of organ systems, and the establishment of body axes. This involves understanding the cellular and molecular processes that drive cell differentiation, tissue morphogenesis, and organogenesis. Embryology is closely related to developmental biology, which explores the genetic, molecular, and environmental factors that influence embryonic development. It investigates how genes and signaling pathways regulate developmental processes, as well as how environmental factors can impact embryonic growth and patterning. Embryology often makes use of model organisms such as fruit flies, zebrafish, mice, and frogs to study developmental processes.[5] These organisms provide valuable insights into the genetic and molecular mechanisms underlying embryonic development and serve as experimental systems for understanding human development. Embryology also encompasses the study of abnormal development and birth defects (teratology). It investigates how genetic mutations, environmental factors, and teratogenic agents can lead to structural or functional abnormalities in embryos and fetuses. Embryology has important medical applications, including in vitro fertilization (IVF), prenatal diagnosis, and understanding the causes of congenital disorders. It also provides insights into regenerative medicine and tissue engineering by studying the processes of tissue formation and organ regeneration. Here are some key aspects of embryology:

1. Comparative embryology: The study of embryonic development in different species has revealed similarities in early stages of development, providing evidence for common ancestry. For example, many vertebrate embryos exhibit similar structures, such as gill slits and tails, during early stages of development, reflecting their shared evolutionary history.

2. Vestigial structures: Embryology has also provided evidence for evolution through the presence of vestigial structures in embryos. These structures are remnants of ancestral features that are no longer functional in adult organisms but are still present during embryonic development, providing clues to evolutionary relationships.

In conclusion, molecular biology, cytology, and embryology offer extensive evidence supporting the theory of evolution, demonstrating the interconnectedness and shared ancestry of all living organisms. In fact, embryology provides a comprehensive understanding of the complex processes involved in the development of organisms from a single fertilized egg to a fully formed individual. It is a foundational field within biology that has implications for human health, reproduction, and our understanding of evolution and genetics. [7] These fields provide a wealth of data that continues to strengthen our understanding of evolutionary processes and the history of life on Earth.

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