

# Principles of Organic Evolution

BI 432

Dr. Craig Moyer

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## What is Evolution?

- Change over time via descent with modification and often diversification from common ancestors.
- Latin for unfold or unroll
- English for change
- Unifying theory of biology

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## The Universal Tree of Life

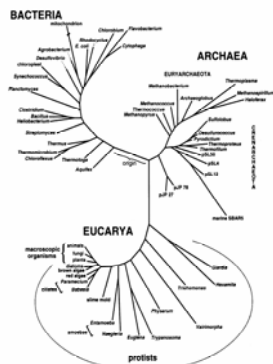


Figure 1. Diagrammatic "classical" phylogenetic tree of life, based on small-subunit ribosomal RNA sequences. Based on analyses of Woese et al. (1990), Olsen et al. (1994), and Gupta (1996).

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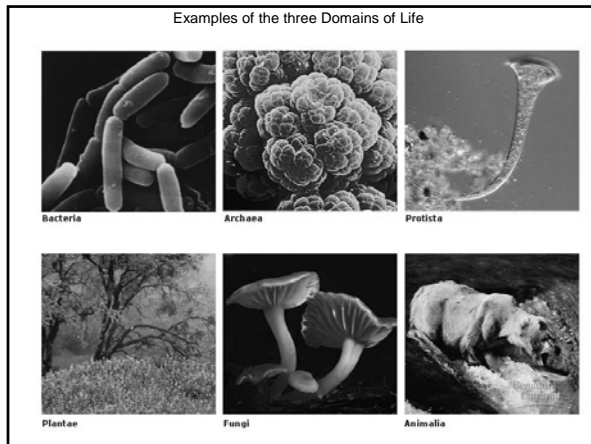
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**What is Evolutionary Biology,  
and Why Is It Important?**

- Fundamental Observations: Diversity and Adaptation
- Evolution as Explanation of Biology
- Evolution as Fact and Theory

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**Fundamental Observations:  
Diversity and Adaptation**

1. Diversity of all characteristics & forms
2. Changes in diversity
3. Apparent "good fit" of organisms to the environment

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Courtesy of R.F. Denno

Why do some species vary so much from place to place, while others hardly vary at all?

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Why do the form and function of organisms fit their environment so well?



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**Evolution as Explanation of Biology:**

1. Levels of organization in biology: From molecules to populations and beyond
2. Proximate and ultimate causation
3. The concept of fortuitous contingency
4. Testable hypothesis using scientific method

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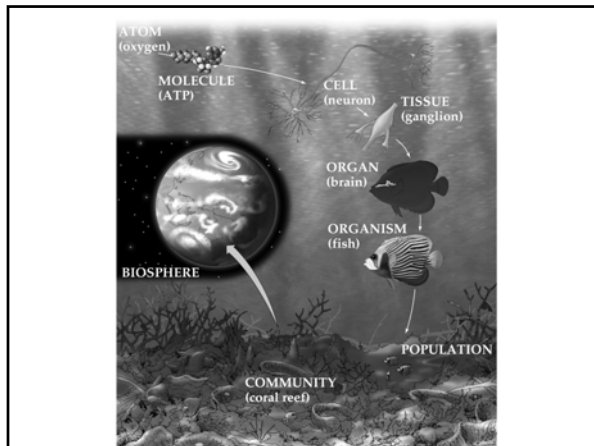
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## Proximate vs. Ultimate Causation

- Why do birds sing in the spring?



<http://www.birdphotography.com/>

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**THE FAR SIDE** By GARY LARSON



An instant later, both Professor Waxman and his time machine are obliterated, leaving the cold-blooded/warm-blooded dinosaur debate still unresolved.

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**Evolution as Fact and Theory:**

1. Change over time
2. Descent with modification
3. Evolution by natural selection

**N.S. = Mechanism of sorting individuals among hereditary variations.**

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**Why do fossils from different sedimentary layers differ as they do?**

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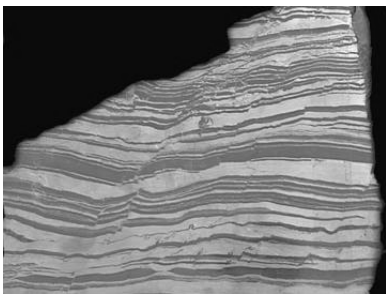
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**BIFs aka Banded Iron Formations**

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## Why Should We Care about Evolutionary Biology?

- It illuminates our understanding of nature.
- It illuminates our understanding of ourselves.
- It helps answer questions in conservation biology.
- An evolutionary understanding can be used to improve the human condition.

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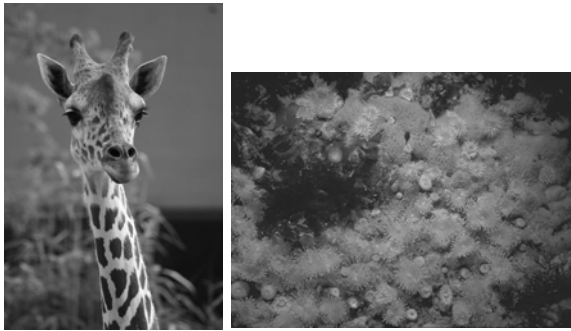


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## How have the various animal body forms evolved?




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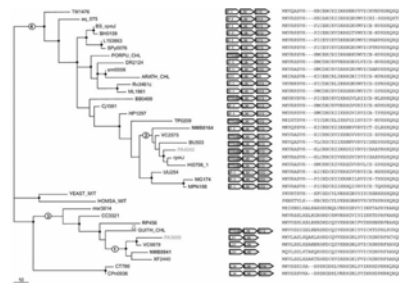


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## Why are some genes remarkably similar among organisms?



Phylogenetic tree, conserved gene context and multiple alignment of 136 ribosomal proteins. A maximum-likelihood unrooted tree was built using the MOLPHY program. Those branches that were supported by bootstrap probability greater than 70% are marked by small black circles.

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**How did complex cell structures evolve?**

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**Why do organisms have sex - sometimes at great cost?**



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**Why do organisms get old and die?**

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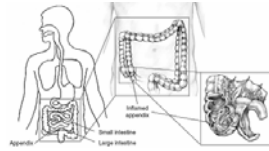
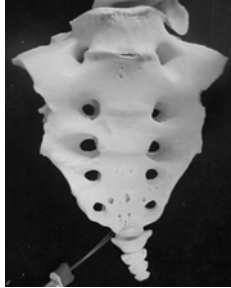
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Evolutionary biology helps us understand our quirks...




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...and how we peopled the earth.




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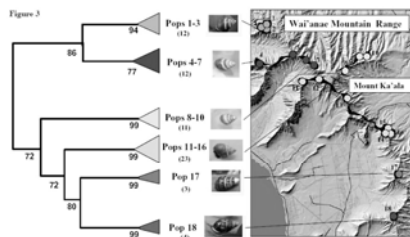
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Which organisms are distinct enough to warrant protection?



○ = *Achatinella mustelina* sampling localities. Genetically defined ESUs are indicated by black outlines.

Halliday & Halliday, 2002  
Molecular Ecology 11(7): 1053-1076

ESU = Evolutionary Significant Unit

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How should we maintain genetic variation?



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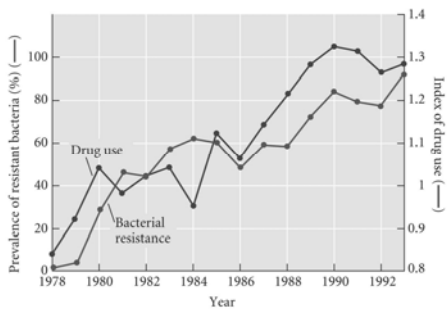
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Evolutionary biology explains why *Moraxella* bacteria become resistant to antibiotics so quickly.



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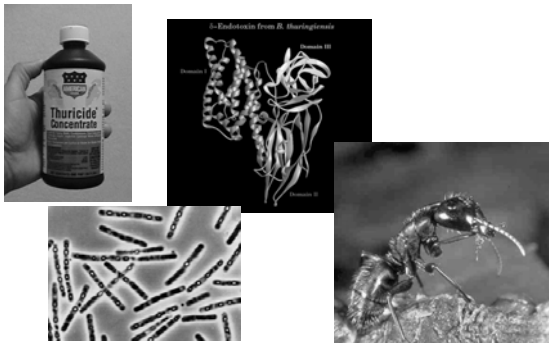
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Similarly, evolutionary biology helps guide efforts to slow the evolution of pesticide resistance in insects.



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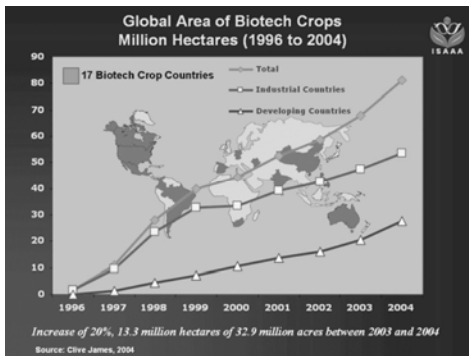
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**Evolutionary biology may help minimize the risks of transgenic crops.**



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