http://www.indiana.edu/~ensiweb/lessons/sp.evid.html

SPECIATION / MACROEVOLUTION EVIDENCE

The evidence for "microevolution" (adaptive changes within species) is supported by an abundance of easily observed examples. However, "macroevolution" (including speciation and the formation of all major groups of organisms by that same process repeated over millions of years), is not as obvious to many people. Nevertheless, there are several different lines of evidence that do indeed point to this very convincingly. Take the time to explore the online links mentioned to further extend your understanding, and, more importantly, have your students experience these, too.

Chromosome Comparisons: First, there are the very striking similarities between all of our chromosomes and those of the apes. Take a look at this at http://www.indiana.edu/~ensiweb/lessons/chro.all.html. For an even sharper version (if you have wideband internet access, e.g. DSL), be sure to scroll to the bottom of that page and download the high resolution PDF file mentioned there. The result is quite suitable for printing copies for your students to study. Consider using one of the ENSI interactive lessons that give students a chance to study these more closely, including clear examples of inversions, etc.: The Chromosome Connection, and Comparison of Human and Chimpanzee Chromosomes.

Most people assume that **chromosome numbers** are a constant for each species and that this supposedly prevents functional fertility between species. It turns out that this is quite true. A particularly revealing article can be found at http://www.gate.net/~rwms/EvoEvidence.html. It's only about two pages, but be sure to read it all, especially the few paragraphs beyond the chromosome diagrams, regarding chromosome variations within a species, and fertility between species. See examples where different species, with different chromosome numbers, have produced fertile offspring.

Even more impressive (in that same article, and also discussed on another site: http://www.edwardtbabinski.us/articles/chimp_chromosome.html) is the clear evidence that our chromosome #2 is a result of the end-to-end **fusion of two shorter chromosomes** (found today in apes: chimps, gorillas, and orangutans). The banding patterns of those chromosomes provide a strong indication of this, and subsequent DNA sequencing further confirms it. This is very compelling, something very hard to explain either by special creation or intelligent design, but easy to explain as an event in evolution.

Our Chromosome Fusion lesson can be used in biology classes for students to find those same DNA sequences using the same internet tools and databases that scientists use. http://www.indiana.edu/~ensiweb/lessons/c.fus.les.html An even more recent lesson runs like a mystery story, with PowerPoint presentation and interactive activity: Mystery of the Matching Marks at http://www.indiana.edu/~ensiweb/lessons/mmm.html

In addition, there are the patterns of **molecular evidence** that make sense only if macroevolution has occurred. One of several lessons on this site is the **comparison of beta hemoglobin in primates**, at http://www.indiana.edu/~ensiweb/lessons/mol.prim.html. Similar studies have been done with a huge number of species and many different proteins, all with similar indications: macroevolution.

And don't overlook the abundant **fossil evidence**, much of it pointing clearly to macroevolution. A most revealing resource showing this is "Transitional Fossils", summarized from a much larger article on the Talk Origins site (see link to the original article in that summary), by Kathleen Hunt. Excellent collection of articles on **transitional fossils** in the Evolution Education & Outreach online journal - click here for reviews and links.

Check out this article on the TalkOrigins site is "29+ Evidences for Macroevolution at http://www.talkorigins.org/faqs/comdesc. Finally, be sure to check out the long list of actual Observed Examples of Speciation, at http://www.talkorigins.org/faqs/faq-speciation.html.

Additional ENSI lessons with examples and mechanisms of macroevolution include the following:
Becoming Whales: http://www.indiana.edu/~ensiweb/lessons/theor.ch.html
Whale Ankles and DNA: http://www.indiana.edu/~ensiweb/lessons/wh.a%26d.les.html
Hominid Cranium Comparisons: http://www.indiana.edu/~ensiweb/lessons/hom.cran.html
Natural Selection - A Cumulative Process: http://www.indiana.edu/~ensiweb/lessons/ns.cum.l.html
Case of the Threespine Stickleback - Model of Macroevolution (Introduces EvoDevo evidence)

Macroevolution & Classification Diagram: Diagram that illustrates macroevolution, and relates it to classification. Includes instructions for its use in class: http://www.indiana.edu/~ensiweb/lessons/sp.evid.pdf