Using laboratory investigations of controversial topics to improve student learning and attitudes

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Biology 151
The old DNA lab

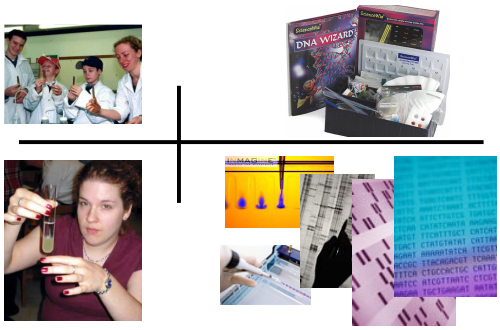
- Isolation of DNA from onion
- Characterization of DNA

Learning and interest

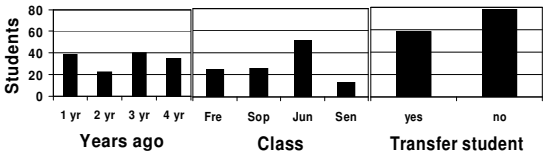
Good

Not good!

Experiences *vs* Expectations



Our Biology 151students



CA content-standard checklist for high school biology students

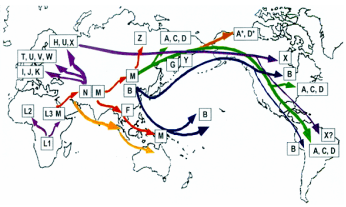
- B.5.c Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.
- B.5.d Students know how basic DNA technology (restriction enzyme digestion, gel electrophoresis, ligation, transformation) is used to construct recombinant DNA molecules.
- B.8.f Students know how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.
- B.8.g Students know how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help estimate how long ago various groups of organisms diverged evolutionarily from one another.

New DNA lab objectives

- Continue DNA isolation skills
- Provide opportunity for investigation
- Engage every student

Intriguing investigative opportunity

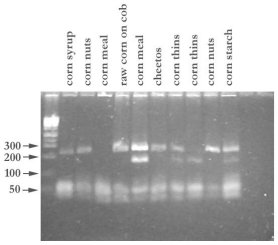
- GMO detection
- Human mitochondrial DNA sequence comparisons

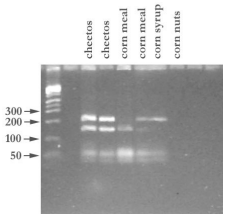


Detection of GM corn

- Every student
  - Isolation
  - PCR amplification
  - Electrophoresis
  - Analysis

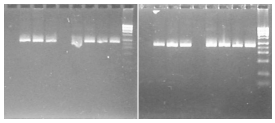
Analysis of corn products





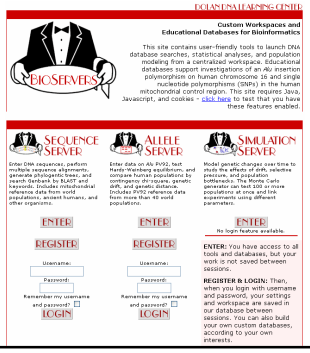
Human mtDNA sequencing

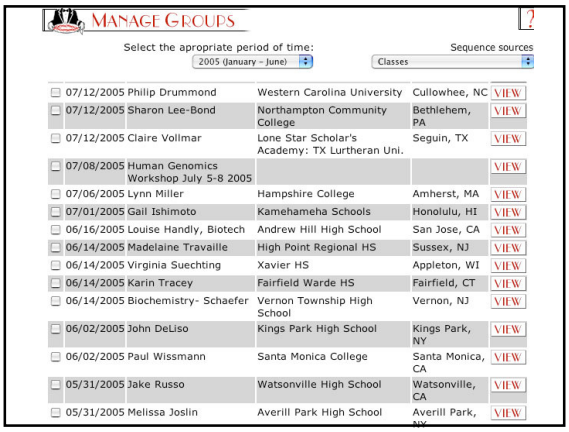
- Isolation
- PCR Amplification
- Electrophoresis

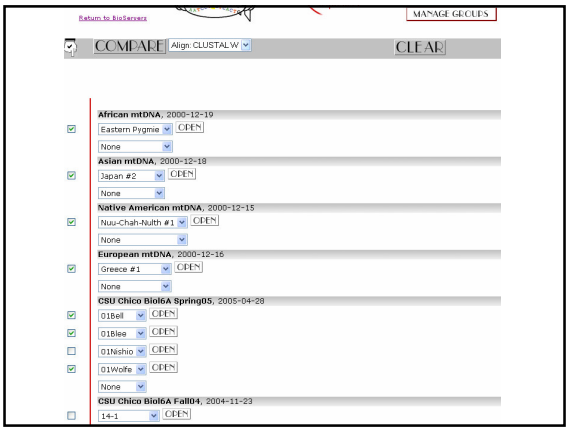


- **Sequencing**
- **Analysis**

www.bioservers.org/bioserver





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01BleeCACGGTACCATAAATACTTGACCAC
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D11    CACGGTACCATAAATACTTGACCAC
J      CACGGTACCATAAATACTTGACCAC
K      TACGGTACCATAAATACTTGACCAC   150
M      TACGGTACCATAAATACTTGACCAC
T      CACGGTACCATAAATACTTGACCAC
U2     TACCGTACCATAAATACTTGACCAC
mt-EveTACGGTACCATAAATACTTGACCAC

01BellCTGTAGTACATAAAAACCCAATCCA
01BleeCTGTAGTACATAGAAACCCAATCCA
A      CTGTAGTACATAAAAACCCAATCCA
D11    CTGTAGTACATAAAAACCCAATCCA
J      CTGTAGTACATAAAAACCCAATCCA
K      CTGTAGTACATAAAAACCCAATCCA   175
M      CTGTAGTACATAAAAACCCAATCCA
T      CTGTAGTACATAAAAACCCAATCCA
U2     CTGTAGTACATAAAAACCCAATCCA
mt-EveCTGTAGTACATAAAAACCCAATCCA
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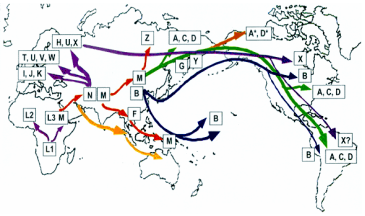
Analysis of self

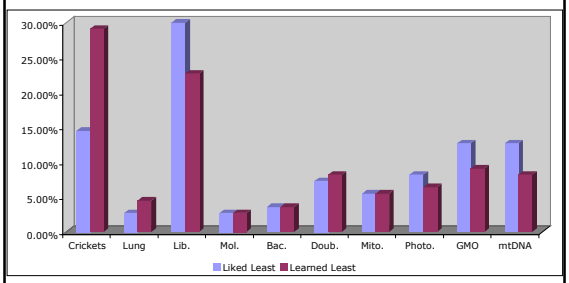
	Nucleotide at position						
Haplotype	223	224	230	249	264	270	278
H	C	T	A	T	C	C	C
K	C	C	A	T	C	C	C
U5	C	T	A	T	C	T	C
X	T	T	A	T	C	C	T
mt-Eve	T	T	G	T	C	C	Y
Student							

Student mtDNA conclusions

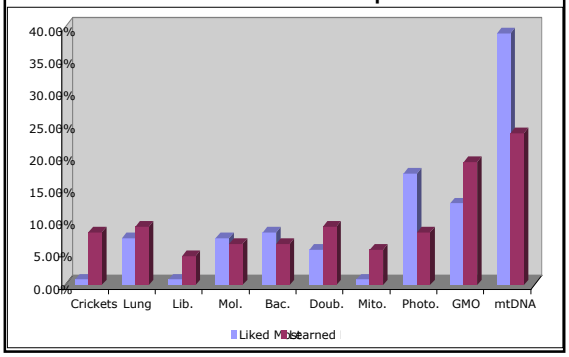
- Maternal lineage
- Divergence



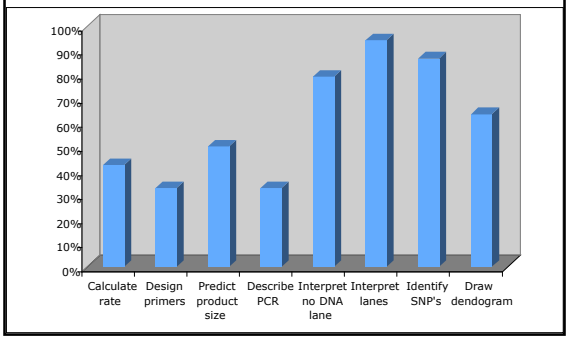
Student Negative Opinions



Student Positive Opinions



Exam Results



Lessons Learned

- If they don't do it, they won't learn it
- The more it's about them they better they learn
- They like high tech
- Controversial topics didn't seem to matter

Cost

- GMO
  - Primers, agarose $80
  - Extraction & amplification $1.70 / student
- Human mtDNA
  - Primers, agarose, chemicals $230
  - Tubes, amplification $2.40 / student
  - Sequencing service $12.75 / student