

Evolution 9

- send answer to iClicker Question 6A now.
 - Molecular Evolution
 - Molecular Phylogeny
 - mutations
 - molecular clocks
 - examples (whales & HIV)
 - iClicker Question 6B
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Due in lab next week:

- ⇒ pre-lab for Molecular Phylogeny (lab manual p. 27 and on-line)
- ⇒ Skull lab report
- ⇒ Meet in W-2-030 & -032

Bio 112 Lecture and Lab Schedule: **REVISED DUE TO SNOW**

Date	Topic	Lab & Due dates
M 1/25	Evolution 1: Introduction	NONE
W 1/27	Evolution 2: Details	
F 1/29	Evolution 3: Population Genetics I	
M 2/1	Evolution 4: Population Genetics II	01: Field Trip:
W 2/3	Evolution 5: Population Genetics III	Museum of Natural History
F 2/5	Evolution 6: Natural Selection	[report due week of 2/8]
M 2/8	Evolution 7: Species & Phylogeny	02: Skulls & Evolution
W 2/10	SNOW ☹️	
F 2/12	Evolution 9: Molecular Phylogeny	[report due week of 2/15]
M 2/15	Presidents' Day	03: Molecular Phylogeny
W 2/17	Evolution 8: Taxonomy & Earth History	
F 2/19	Themes 1: Major Groups & Nutrition	[report due week of 2/22]
M 2/22	Themes 2: Size and Scale	04: Aipotu IV
W 2/24	Themes 3: Size, Respiration, and Circulation	
F 2/26	Themes 4: Reproduction	[report due week of 3/1]
M 3/1	EXAM 1: Evolution & Themes	05: Eukaryotic Cells
W 3/3	Plants 1: Introduction	
F 3/5	Plants 2: Mosses & Ferns	[report due week of 3/8]
M 3/8	Plants 3: Gymnosperms & Angiosperms I	06: Plant Diversity I
W 3/10	Plants 4: Angiosperms II	
F 3/12	Plants 5: Monocots & Dicots	
M 3/15	SPRING BREAK	NONE
W 3/17	SPRING BREAK	
F 3/19	SPRING BREAK	
M 3/22	Animals 1: Introduction	06: Plant Diversity II
W 3/24	Animals 2: Invertebrates I	
F 3/26	Animals 3: Invertebrates II	[report due week of 4/5]
M 3/29	Animals 4: Invertebrates III	06: Plant Diversity III
W 3/31	Animals 5: Vertebrates	Lab Practical Exam
F 4/2	Physiology 1: Nervous Systems Introduction	
M 4/5	EXAM 2: Themes & Plants	07: Animal Diversity I: Trout
W 4/7	Physiology 2: Resting Potential	
F 4/9	Physiology 3: Action Potential	
M 4/12	Physiology 5: Input & Output	07: Animal Diversity II: Squid
W 4/14	Physiology 6: Scent & Smell	[report due week of 4/26]
F 4/16	Physiology 7: Muscle	
M 4/19	Patriots' Day	07: Animal Diversity III:
W 4/21	Physiology 8: Neurotoxins & Excretion	Lab Practical Exam
F 4/23	Ecology 1: Introduction & Climate	
M 4/26	EXAM 3: Animals & Physiology	08: Animal Behavior
W 4/28	Ecology 2: Population Growth	
F 4/30	Ecology 3: Interactions I	[report due week of 5/3]
M 5/3	Ecology 4: Interactions II	09: Phylogenetic Collection
W 5/5	Ecology 5: Interactions III	
F 5/7	Ecology 6: Community Structure	[rpt. to TA mailbox wk of 5/10]
M 5/10	Ecology 7: Ecosystems	NONE
W 5/12	Ecology 8: Biogeochemical Cycles	

Changes:

- Evolution 8 and 9 switched
- Physiology 4 cancelled
- Wednesday afternoon and night labs (sections 5, 6, and 11) will do **both** *Skulls & Evolution* and *Molecular Phylogeny* on 2/17. Their HMNH reports will be due 2/17; the *Skulls* and *Mol Phyl* reports will be due on 2/24.

Be prepared!

2/10/10

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Molecular Evolution = changes in genes (DNA) over evolutionary time

* due to mutation = changes in DNA sequence ^{sometimes} → changes in amino acid sequence of proteins

Molecular Phylogeny - using differences in DNA/protein sequences

Molecular Phylogeny - using differences in DNA/protein sequences
to infer evolutionary relationships

based on : random accumulation of mutations over time

∴ the more time has passed since last common ancestor
(LCA) the more different the sequences will be

or the more distantly related two organisms are,
the more different the sequences will be
(i.e. vice versa)

* mutations are random, but averaged over long term
accumulate at ~ constant rate

depending on ① mutation rate

② "flexibility" of sequences - how many
mutations it can take & still function

⇒ "molecular clock"

Molecular Phylogeny Handout

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Bio 112 Molecular Phylogeny Handout

Question: What is the closest land relative of a whale, a Hippo, a Cow, or a Deer?

Data: DNA sequences from the same part of the same gene (the gene for casein, a protein found in milk) in all 4 organisms.

use "molecular clock" to find out - count # of differences

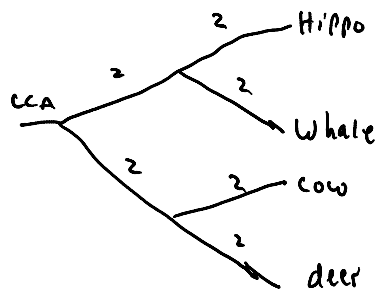
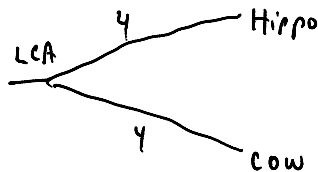
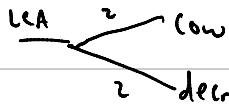
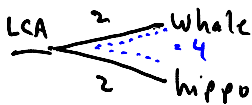
Whale: AATCCCCAAAGCTAAGGAGACTATCCTTCCTAAGCATAAAGAAATGCCCTTCCTATATC } 4
 Hippo: AGTCCCCAAAGCTAAGGAGACTATCCTTCCTAAGCATAAAGAAATGCCCTTCCTAAATC } 8
 Cow: AGTCCCCAAAGTGAAGGAGACTATGGTTCCTAAGCACAAAGGAAATGCCCTTCCTAAATA } 4
 Deer: AGTCTCCGAAGTGAAGGAGACTATGGTTCCTAAGCACGAAGAAATGCCCTTCCTAAATA } 4

how to show differences? tree diagram where

- ① distance* proportional to # of differences (molecular clock)
 - ② all branches same length* from LCA (all current organisms have been evolving the same amount of time)
- * 2 ways to show distance

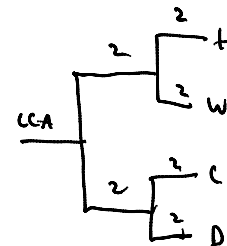
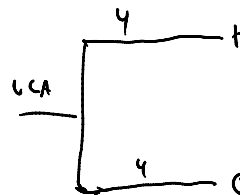
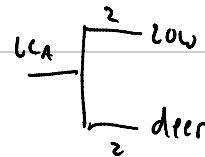
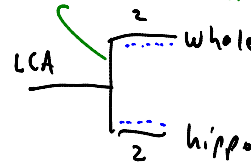
④ path length matters

start with smallest distances



⑤ only ↔ distance matters

this length doesn't matter

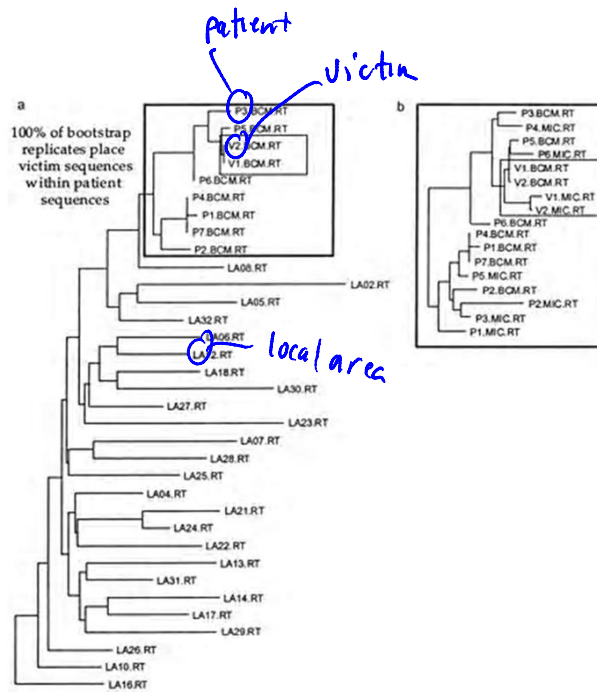


= map showing evolutionary relationships = phylogenetic tree

∴ hippo is closest land relative of whale (of these mammals)
(predict whale-cow = 8 - its really 9 = close enough)

Molecular phylogeny & criminal justice

- 1994: Dr. Richard Schmidt accused of injecting his ex-girlfriend (the Victim) with HIV (AIDS virus) from one of his patients.
- HIV evolves very rapidly, even leading to multiple different sequences *in the same patient!*
- Police collected HIV samples from victim (V), Dr. Schmidt's patient (P), and many local HIV⁺ individuals from the community who were unrelated to the case (LA)
- They then used computer tools to construct the following phylogeny.



From: "Molecular evidence of HIV-1 transmission in a criminal case" by Michael L. Metzker, David P. Mindell, Xiao-Mei Liu, Roger G. Ptak, Richard A. Gibbs, and David M. Hillis. *Proceedings of the National Academy of Sciences* 99:22 14292-14297 (2002).

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