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FIG. 1 a. Three possible phylogenetic trees for guinea-pigs (Gp), primates (Pr), myomorphs (My), and an outgroup (Ou). Tree I represents the traditional view that the guinea-pig and the myomorphs form one clade. b. Five of 15 possible alternative phylogenetic trees for primates, artiodactyls (Ar), myomorphs, guinea-pigs, and an outgroup. c. Branch lengths from a common node to humans (Hu), myomorphs (My) and guinea-pigs (Gp) computed from the number of nucleotide substitutions per nonsynonymous site ( $K_A$ ) and per synonymous site ( $K_S$ ) given in Table 3.

TABLE 1 Number of informative sites supporting each of the three possible alternative phylogenetic trees (Fig. 1a), and minimum number of amino-acid replacements required for each tree (in parentheses)

Protein	Out-group	$L^*$	$I^\dagger$	Primates (Pr), guinea-pig (Gp) and myomorphs (My)			Artiodactyls (Ar), guinea-pig (Gp) and myomorphs (My)				
				Tree I (Gp-My)	Tree II (Gp-Pr)	Tree III (Pr-My)	L	I	Tree I (Gp-My)	Tree II (Gp-Ar)	Tree III (Ar-My)
$\beta$ -globin	MA	145	9	5 (189)	0 (194)	4 (189)	145	11	7 (210)	0 (217)	4 (213)
$\alpha$ -crystallin A chain	MA	162	1	0 (33)	1 (32)	0 (33)	162	1	1 (29)	0 (30)	0 (30)
$\alpha$ -globin	MA	145	9	4 (170)	0 (174)	5 (168)	145	9	2 (190)	1 (191)	6 (185)
$\alpha$ -lactalbumin	MA	120	17	4 (148)	8 (143)	5 (147)	120	12	1 (188)	6 (183)	5 (184)
glucagon	MA	29	0	0 (5)	0 (5)	0 (5)	29	0	0 (5)	0 (5)	0 (5)
pancreatic ribonuclease	MA	122	7	1 (193)	5 (189)	1 (193)	122	5	2 (223)	3 (222)	0 (225)
'big' gastrin	MA	31	1+gap	0 (22)	0 (22)	1+gap(21)	31	1+gap	0 (28)	0 (28)	1+gap(27)
adrenocorticotrophin	OS	39	1	0 (11)	0 (11)	1 (10)	39	1	0 (13)	0 (13)	1 (12)
lipocortin	PG	345	19	4 (179)	4 (179)	11 (172)	25	2	1 (31)	1 (31)	0 (32)
pancreatic polypeptide	CK	36	0	0 (15)	0 (15)	0 (15)	36	1	0 (38)	1 (37)	0 (38)
proinsulin	CK	78	4	1 (74)	1 (74)	2 (73)	78	4	2 (87)	0 (89)	2 (87)
lipoprotein lipase	CK	447	20	2 (206)	6 (202)	12 (196)	447	21	2 (218)	9 (212)	10 (211)
$\beta$ -nerve growth factor	CK	171	11	5 (84)	1 (88)	5 (84)	123	7	5 (38)	0 (43)	2 (41)
vasoactive intestinal peptide	CK	28	1	0 (8)	0 (8)	1 (7)	28	1	0 (8)	0 (8)	1 (7)
vasopressin-neurophysin precursor	TD	100	2	0 (60)	2 (58)	0 (60)	102	1+gap	1+gap(58)	0 (59)	0 (59)
Total		1998	102+gap	26 (1,397)	28 (1,394)	48 (1,373)+gap	1,632	77+2 gaps	24 (1,364)+gap	21 (1,368)	32 (1,356)+gap

Sequences in this and other tables from the GenBank, EMBL, NBRF-PIR, and Swiss Prot DNA or protein data libraries. The outgroup species used are CK, chicken; OS, ostrich; PG, pigeon; TD, toad (*Bufo japonicus*); and MA, marsupials. Opossum (*Didelphis virginiana*) and red kangaroo (*Macropus rufus*) used for  $\beta$ -globin and  $\alpha$ -crystallin A chain; opossum and Eastern grey kangaroo (*M. giganteus*) for  $\alpha$ -globin; red-necked wallaby (*M. rufogriseus*) for  $\alpha$ -lactalbumin; opossum for glucagon and 'big' gastrin; and red kangaroo for pancreatic ribonuclease. For the caviomorph group, guinea-pig is used in all cases, except that chinchilla, cuis, and capybara are used for pancreatic ribonuclease and guinea-pig and chinchilla are used for 'big' gastrin. For the other three eutherian groups the species used are: human, rhesus monkey, spider monkey, mouse, rat, golden hamster, cow, goat, and Bactrian camel (*Camelus bactrianus*) for the  $\beta$ -globin; human, rhesus monkey, galago (bush baby), mouse, rat, golden hamster, cow, camel (*Camelus dromedarius*) and pig for  $\alpha$ -crystallin A chain; human, baboon, spider monkey, mouse, rat, golden hamster, cow, camel and pig for  $\alpha$ -globin; human, rat, cow, goat and camel for  $\alpha$ -lactalbumin; human, rat and pig for glucagon; human, mouse, rat, golden hamster, cow, camel, and giraffe for pancreatic ribonuclease; human, rat, cow and pig for 'big' gastrin; human, rat, cow and pig for pancreatic polypeptide; human, mouse, rat, cow and pig for adrenocorticotrophin; human, rat and pig for lipocortin; human, mouse, rat, cow and pig for proinsulin; human, mouse and cow for lipoprotein lipase; human, mouse and cow for  $\beta$ -nerve growth factor; human, rat and pig for vasoactive intestinal peptide; human, rat, cow and pig for vasopressin-neurophysin precursor. Informative sites are all those amino-acid positions at which the number of substitutions required differs among the possible alternative phylogenetic trees. An informative site is said to support a tree if that tree requires the least number of substitutions at that site in comparison with the alternative possible trees. Note that the number of informative sites supporting trees I and II are 26 and 28, but tree I requires 3 additional substitutions. This is because replacement of an amino acid by another at a certain site may sometimes require more than one nonsynonymous nucleotide substitution at the DNA level.

\*  $L$ , number of aligned amino-acid sites.  
 $\dagger I$ , number of informative sites.