

c) ATP synthase: ultrametric \rightarrow use UPGMA

①

	human	e.coli	bacsu	mouse	yeast	schpo
human	0	0.5	0.5	0.1	0.4	0.4
e.coli		0	0.3	0.5	0.5	0.5
bacsu			0	0.5	0.5	0.5
mouse				0	0.4	0.4
yeast					0	0.3
schpo						0

②

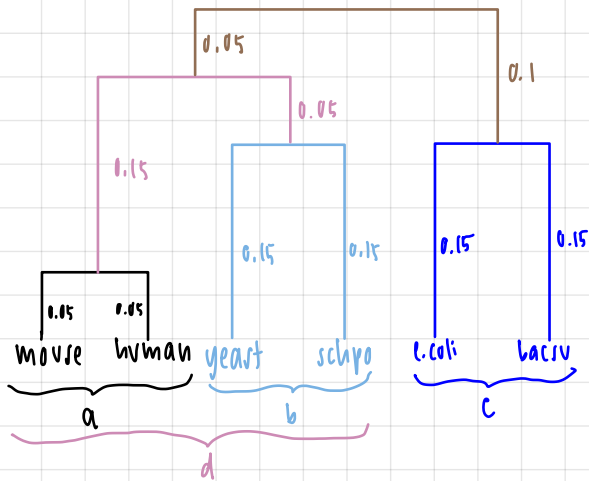
	a	e.coli	bacsu	yeast	schpo
a	0	0.5	0.5	0.4	0.4
e.coli		0	0.3	0.5	0.5
bacsu			0	0.5	0.5
yeast				0	0.3
schpo					0

$$\begin{aligned} d(a,e) &= \frac{0.5+0.5}{2} = 0.5 \\ d(a,b) &= \frac{0.5+0.5}{2} = 0.5 \\ d(a,y) &= \frac{0.4+0.4}{2} = 0.4 \\ d(a,s) &= \frac{0.4+0.4}{2} = 0.4 \end{aligned}$$

③

	a	e.coli	bacsu	b
a	0	0.5	0.5	0.4
e.coli		0	0.3	0.5
bacsu			0	0.5
b				0

$$\begin{aligned} d(b,a) &= \frac{0.4+0.4}{2} = 0.4 \\ d(b,e) &= \frac{0.5+0.5}{2} = 0.5 \\ d(b,bac) &= \frac{0.5+0.5}{2} = 0.5 \end{aligned}$$



④

	a	b	c
a	0	0.4	0.5
b		0	0.5
c			0

$$\begin{aligned} d(c,a) &= \frac{0.5+0.5}{2} = 0.5 \\ d(c,b) &= \frac{0.5+0.5}{2} = 0.5 \end{aligned}$$

⑤

	d	c
d	0	0.5
c		0

$$\begin{aligned} |a| &= 2 \quad |b| = 2 \\ d_{ac} &= \frac{2(0.5) + 2(0.5)}{4} \\ h &= 0.25 \end{aligned}$$