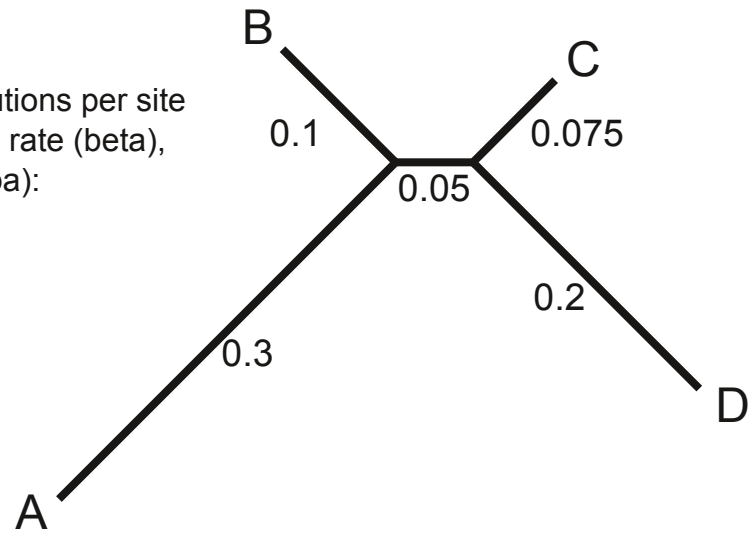
Homework 3: Edge Lengths and Transition Probabilities

For the K80 model, the edge length in substitutions per site is a function of time (t), the overall substitution rate (beta), and the transition/transversion rate ratio (kappa):

$$\nu = (\kappa + 2)\beta t$$

The rate ratio **kappa** is usually considered a global parameter (applies to every part of the tree), but the substitution rate **beta** is edge-specific. If **kappa = 5** and **t = 1**, what is the value of beta for each edge of the tree shown? **Fill in the second column** of the table below with these values.

The formulas on the right show how to calculate transition probabilities for both transition-type substitutions (e.g. A to G) or transversion-type substitutions (e.g. A to T). Calculate the probability of a transition from A to G and a transversion from A to T and **insert these values into the 3rd and 4th columns** of the table below.



Probability of a transition-type substitution:

$$\frac{1}{4} + \frac{1}{4}e^{-4\beta t} - \frac{1}{2}e^{-2\beta t(\kappa+1)}$$

Probability of a transversion-type substitution:

$$\frac{1}{4} - \frac{1}{4}e^{-4\beta t}$$

Is it more surprising to see a substitution across the longest edge (0.3) or the shortest edge (0.05) of the tree? Briefly explain why the probabilities in the 3rd and 4th column are relevant.

Are transition-type or transversion-type substituitions more probable? Using relative rates, explain why this is the case.

Use 5 decimal places precision for all answers.

Edge length	beta	Pr(transition A to G)	Pr(transversion A to T)
0.05	0.00714	0.03403	0.00704
0.075			
0.1			
0.2			
0.3			