

# NG86 example

- The observed  $N/S$  ratio (1 . 0) is **lower** than the expected  $EN/ES$  ratio (4 . 05).
- The ratio of the ratios  $(N:S) / (EN:ES)$  yields  $dN/dS = 1/4.05 \sim 0.25$ .
- This ratio quantifies the **excess** or **paucity** of non-synonymous substitutions and is near  $dN/dS = 1$  for neutrally evolving sequences/sites.
- Because there are **fewer** non-synonymous substitutions than expected under neutrality, we conclude that most non-synonymous mutations are **removed by natural selection**, i.e., the sequences are under **negative selection**
- **If there were more** non-synonymous substitutions than expected, we would conclude that many non-synonymous mutations are **fixed due to natural selection**, i.e., the sequences are under **positive selection**

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- How reliable is the inference based on only **6** codons?
- Obtain sampling variance via bootstrap (or by limiting approximations)
- In this case, dN/dS is **significantly** less than **1.0** ( $p \sim 0.01$ )

