**Supplementary figure 1**

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| **Mutation** | **pH** | **Temperature (°C)** | **Predicted free Gibbs energy change value (ΔΔG)** |
| VP1-L97R  | 7 | 25 | -0.65(Destabilizing) |
| 5 | 25 | -0.70(Destabilizing) |
| 7 | 55 | -0.51(Destabilizing) |
| VP1-E167G  | 7 | 25 | -1.15(Destabilizing) |
| 5 | 25 | -1.10(Destabilizing) |
| 7 | 55 | -0.74(Destabilizing) |
| VP1-E145Q  | 7 | 25 | -0.80(Destabilizing) |
| 5 | 25 | -0.89(Destabilizing) |
| 7 | 55 | -0.71(Destabilizing) |