Biological Thermodynamics: The Thermal Set Point and the Origins of Life

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Application of the Planck-Benzinger thermal work function to biological systems has demonstrated a basic pattern for life processes, in that there is a lower cutoff point, $\langle T_h \rangle$, where entropy is favorable but enthalpy is unfavorable, i.e. $\Delta H^o(T_h)(+) = T\Delta S^o(T_h)(+)$, and upper cutoff, $\langle T_m \rangle$, above which enthalpy is favorable but entropy unfavorable, i.e. $\Delta H^o(T_m)(-) = T\Delta S^o(T_m)(-)$. Only between these two limits, where $\Delta G^o(T) = 0$, is the net chemical driving force favorable for interacting biological processes [1-10]. In the case of water vapor condensation the compensatory temperatures, $\langle T_h \rangle$ and $\langle T_m \rangle$, are 30 K and 380 K. Each living system is made up, in some part, of water. Hence we suggest that the single point at which the system is its most stable, defined as the thermal set point, $\langle T_S \rangle$, must fall between the limits of 30 K and 380 K. We find that each biological system will exhibit a negative minimum of Gibbs free energy change at this well-defined temperature, $\langle T_S \rangle$. Each system will have its own unique value of $\langle T_S \rangle$, where the bound unavailable energy $T\Delta S^o = 0$. At this point, $\Delta H^o(T_S)(-) = \Delta G^o(T_S)(-)_{minimum}$, the maximum work can be accomplished. For water vapor condensation, thermal set point falls at 260 K and $\langle T_{Cp} \rangle$ at $\Delta Cp^o(T) = 0$ is 130 K. In examining interacting protein systems, it would appear that the heat capacity change of reaction of water within the system determines the behavior of the other thermodynamic functions. It is apparent from the application the Chun approach to studies of numerous biological interactions that the origins of life in any system are inevitably linked to a single, unique thermal set point.

References

1. Chun, P. W. (2000) Biophysical J. 78: 416-429.
2. Chun, P. W. (2000) Int'l. J. Quantum Chem. 80: 183-203
3. Chun, P. W. (2001) J. Colloids and Surfaces 118: 183-203.
4. Chun, P. W. (2001) Int'l. J. Quantum Chem. 85: 697-712.
5. Chun, P. W. (2002) Int'l. J. Quantum Chem. 87: 323-353.
6. Chun, P. W. (2003) Biophysical. J. 84: 1352-1369.
7. Chun, P. W. (2003) The Scientific World Journal 3: 176-193
8. Chun, P. W. (2004) Int'l. J. Quantum Chem. 100: 994-1002.
9. Chun, P. W. (2005) Physica Scripta T118: 219-222.
10 Chun, P. W. (2007) Int'l. J. Quantum Chem. In press.