

# Hsp90-Induced Evolution: Adaptationist, Neutralist, and Developmentalist Scenarios

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## Abstract

Recent work on the heat-shock protein Hsp90 by Rutherford and Lindquist (1998) has been included among the pieces of evidence taken to show the essential role of developmental processes in evolution; Hsp90 acts as a buffer against phenotypic variation, allowing genotypic variation to build. When the buffering capacity of Hsp90 is altered (e.g., in nature, by mutation or environmental stress), the genetic variation is "revealed," manifesting itself as phenotypic variation. This phenomenon raises questions about the genetic variation before and after what I will call a "revelation event": Is it neutral, nearly neutral, or non-neutral (i.e., strongly deleterious or strongly advantageous)? Moreover, what kinds of evolutionary processes do we take to be at work? Rutherford and Lindquist (1998) focus on the implications of non-neutral variation and selection. Later work by Queitsch, Sangster, and Lindquist (2002) and Sangster, Lindquist, and Queitsch (2004) raises the possibility that Hsp90 buffering may play the role that was played by drift in Sewall Wright's shifting balance model, permitting transition from one adaptive peak to another. However, Ohta (2002) suggests that much of this variation may be nearly neutral, which in turn, would imply a strong role for drift as well as selection. The primary goal of this paper is to illuminate the alternative scenarios and the processes operating in each. At the end, I raise the possibility of a synthesis between evo-devo and nearly neutral evolution.

**Keywords:** adaptationist, developmental buffer, evo-devo, evolution, evolvability, heat shock protein, Hsp90, natural selection, nearly neutral theory, random genetic drift

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