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The All Pervasive Principle of Repetitious Recurrence Governs Not Only Coding Sequence Construction But Also Human Endeavor in Musical Composition

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Abstract. Organisms which have evolved on this earth are governed by multitudes of periodicities; tomorrow is another today, and the next year is going to be much like this year. Accordingly, the principle of repetitious recurrence pervades every aspect of life on this earth. Thus, individual genes in the genome have been duplicated and triplicated often to the point of redundancy, and each coding sequence consists of numerous variously truncated as well as variously base-substituted copies of the original primordial building block base oligomers and their allies. This principle even appears to govern the manifestations of human intellect; musical compositions also rely on this principle of repetitious recurrence. Accordingly, coding base sequences can be transformed into musical scores using one set rule. Conversely, musical scores can be transcribed to coding base sequences of long open reading frames.

"Whereas ordinary mortals are content to mimic others, creative geniuses are condemned to plagiarize themselves" is my shorter, albeit inarticulate, version of what Van Veen said in *Ada* by Vladimir Nobokov. Indeed, it seems that vaunted geniuses seldom invented more than one modus operandi during their lifetimes, and even civilization has largely been dependent upon plagiarizing a small number of creative works; e. g., the multitudes of Gothic churches can be viewed as pan European plagiarism of the abbey church of St. Denis and/or the cathedral at Sens. This is not surprising for new genes sensu stricto have seldom been invented. Evolution rather relies on plagiarizing an old and tested theme; the mechanism of evolution by gene duplication (Ohno 1970). For example, the adaptive immune system of vertebrates has apparently evolved by plagiarizing one ancestral gene. This gene encoded a 90 or so residue long polypeptide chain which folded itself to form two β-barrel structures held together by one intrachain disulfide bridge. Included in this superfamily of genes are not only those responsible for antigen-binding immunoglobulins (Igs) and T-cell receptors but also those responsible for class I and class II major histocompatibility antigens and even for the transmembrane receptor for poly-IgM and IgA (Mostov et al. 1984). Inasmuch as reliance on repetitions of tested themes has been the hallmark of all lives evolved on this earth, the redundancy resulting from this has become very prominent in mammalian genomes. Most of the nine or more factors involved in blood clotting that finally convert fibrinogen to fibrin are inert serine proteases that become activated by cleavage induced by a preceding activated serine protease; why should there not be one or two instead of nearly ten, and why should factor VIII be so enormous, being comprised of 2332 amino acid residues (Gitschier et al. 1984)? Similarly, the tyrosine kinase domain is an integral component of membrane receptors for various growth factors such as insulin and the epidermal growth factor. In addition, however, new *c-onc* gene loci for tyrosine kinase are being discovered at an alarming rate (Martin-Zaca et al. 1985). Interspecific comparison also revealed different redundancies involving various gene loci for class I as well as class II major histocompatibility antigens (Klein and Figueroa, in press).

In this paper, we shall show that this principle of repetitious recurrence pervades both the construction of coding sequences in the genome, which can be regarded as being representative of nature, and musical composition which can be regarded as the most abstract and therefore the most intellectual expression of nurture.

Historical development of coding base sequences and musical composition. The principle of repetitious recurrence also applies to the construction of individual coding sequences. Available evidence indicates that all the coding base sequences were—at their inception eons ago—repeats of base oligomers. They therefore encode polypeptide chains of exact periodicities (Ohno and Epplen 1983, Ohno

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