Molecular Mechanism of Cell Differentiation of Multi-Cellular Organism and Its Carcinogenic Transformation by Mutation Based on the Molecular Anvil Model of an Enzyme and Non-Equilibrium Thermodynamics

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In a multi-cellular organism, a tissue or an organ grows and stops its growth when it reaches to a definite size. Similar phenomenon is observed in cultured tissue as contact inhubition. But in cancer cells, they grow endlessly without regulation. In this paper molecular mechanism of these phenomena is elucidated employing the molecular anvil model of an enzyme and non-equilibrium thermodynamics. The molecular anvil model can explain high catalytic power and high specity of enzyme [1]. It is also derived from this model that enzyme activity changes by deformation of enzyme molecule due to mechanical force. This mechano-chemical property of enzyme plays an important role in regulating enzyme activity by mechanical force. It is also derived from this model that substitution of amino-acid in an enzyme molecule causes change of its activity, specificity and optimum conditions. A chain reaction composed of a series of many enzyme reactions always forms an autocatalytic system. Autocatalytic chemical reaction systems enter into chemical oscillation under favorable conditions. Concentration of the oscillatory chemical reaction products change periodically and during some period it reaches to high enough values for the product to act as trigger or switching of other biochemical reactions. External force applied to a cell is transferred instantly to all enzyme molecules bound to cell skeleton spreading throughout the cell and cause their molecular deformations. Starting and stopping of chemical oscillations depends on the critical values of activity ratio of the two competing enzymes. When the activities of the two competing enzymes change oppositely by deformation, the change of activity ratio of the two competing enzymes is amplified and very small external force applied to the cell from the surrounding cells act as a trigger of regulation of the cell growth. This is the molecular mechanism of normal cells whose growth signals are properly regulated. If the activities of the relevant enzymes are changed by the amino-acid substitution caused by mutation, proper regulation of growth may be destroyed and cancer may occur.

[1] K.Amaya *J.Inclusion.Phenomena.* **5,** 535-544 (1987).