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Structural Mechanism for T7 RNA Polymerase Translocation. Y. Whitney Yin, Chemistry and Biochemistry, Univ. of Texas at Austin, 2500 Speedway, MBB 3.422, Austin, TX 78712, whitney.yin@mail.utexas.edu, Thomas A Steitz, Molecular Biophysics and Biochemistry, Yale Univ.

During gene expression, RNA polymerases catalyze template dependent RNA synthesis. The polymerases are capable of converting the chemical reaction energy into the mechanical movement along the template, thereby, belongs to a class of molecules named molecular motors. To study the mechanism of translocation, we determined crystal structures of T7 bacteriophage RNA polymerase at each step of a single nucleotide addition cycle: a substrate complex with a non-hydrolyzable nucleotide analogue alpha,beta-methylene-ATP, a product complex captured at the pre-translocation conformation and a post-translocation elongation complex. These structures revealed that during translocation the fingers domain acts like a lever-arm to move the polymerase in the direction along the RNA:DNA heteroduplex axis at the step size of one base pair, 3.4 Å. An active site loop connected to the lever-arm moves in and out of the nucleotide binding site and functions like a pawl on a ratchet device during translocation, structurally links nucleotide selection with frameshift prevention. From these structural results we demonstrate that pyrophosphate product release triggers a power stroke movement of the polymerase along DNA during translocation.