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A sex hormone catalyzes biological nitrogen fixation

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Abstract: Biological nitrogen fixation (BNF) involves the conversion of atmospheric nitrogen gas (N_2) into ammonia (NH_3), which plants and some other organisms can use to synthesize essential organic compounds such as proteins and nucleic acids. This process is crucial for the global nitrogen cycle and is primarily carried out by certain prokaryotic organisms, including bacteria and archaea. Our research uncovered a remarkable relationship between BNF and testosterone, the primary male sex hormone. In humans, testosterone is vital for the development of male reproductive tissues, such as the testicles and prostate, and it also promotes secondary sexual characteristics. We conducted molecular docking studies with testosterone and the nitrogenase enzyme, which comprises two components: the Fe protein (NifH) and the FeMo protein (NifDK). These components facilitate electron transfer and the conversion of N_2 to NH_3, respectively. Our results revealed that testosterone binds to NifH and NifDK with excellent binding affinities, demonstrating superb non-covalent bonding interactions. In parallel, we performed laboratory experiments by growing nitrogen-fixing bacteria in the presence and absence of testosterone. We measured their nitrogen fixation rates and confirmed that testosterone enhances BNF. It has been reported that certain Firmicutes can synthesize testosterone or promote its reabsorption through deconjugation, particularly in the human gut. Additionally, the human gut microbiota, which includes strains such as Klebsiella and Clostridiales, has the potential to fix nitrogen. Therefore, testosterone may enhance BNF in the human gut, providing essential nitrogen nutrition for malnourished individuals. This phenomenon might also apply to soil ecosystems, where testosterone is naturally present, potentially boosting nitrogen fixation in these environments as well.

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