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On the cluster basis of $\mathbb{Z}[x_{1,1}, \dots, x_{3,3}]$

We show that the set of cluster monomials for the cluster algebra of type D_4 forms a basis of the \mathbb{Z} -module $\mathbb{Z}[x_{1,1}, \dots, x_{3,3}]$. We also show that the transition matrices relating the cluster basis of this module to the natural and the dual canonical bases are unitriangular and nonnegative. These results support a conjecture of Fomin and Zelevinsky on the equality of the cluster and dual canonical bases of $\mathbb{Z}[x_{1,1}, \dots, x_{3,3}]$. In the event that this conjectured equality is true, our results also imply an explicit factorization of each dual canonical basis element of the module as a product of cluster variables.