The vibration and stability analyses are presented for axially compressed three-layered truncated conical shells with a functionally graded (FG) middle layer surrounded by elastic media. The material properties of functionally graded materials (FGMs) are assumed to be graded in the thickness direction according to simple power law and exponential distributions in terms of the volume fractions of the constituents. Five sets of the material mixture are considered. The Pasternak model is used to describe the reaction of the elastic medium on the truncated conical shell. The fundamental relations, the modified Donnell-type dynamic stability and compatibility equations for the three-layered truncated conical shell with an FGM middle layer are derived. The governing equations are solved by using the Galerkin method and obtained expressions for dimensionless frequency parameters and dimensionless critical axial loads for three-layered truncated conical shells with the FG middle layer with and without an elastic foundation. The numerical results reveal that variations of the shell thickness-to-FGM thickness ratio, lengths-to-radius ratio, Winkler foundation stiffness, shear subgrade modulus of the foundation, material mixture and compositional profiles of the FG middle layer have significant effects on the values of dimensionless critical axial load and dimensionless frequency parameter. The results are verified by comparing the obtained values with those in the existing literature.