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The standard Dirac operator in physics involves representations of the Clifford algebra in $3 + 1$ spacetime dimensions, usually expressed in terms of 4×4 complex matrices. Rewriting these representations over the quaternions naturally leads to a formalism that treats the massive and massless Dirac equations on an equal footing, and that naturally lives in $5 + 1$ spacetime dimensions. Extending to the octonions in turn extends the spacetime dimension to $9 + 1$; remarkably, solutions to the octonionic Dirac equation must be quaternionic. Some applications to physics will be briefly discussed if time permits. (Received August 29, 2017)