I develop a novel method for computing globally accurate solutions to recursive macro-epidemic models featuring aggregate uncertainty and a potentially large number of state variables. Compared to the previous literature which either restricts attention to perfect-foresight economies amendable to sequence-space representation or focuses on highly simplified, low dimensional models that could can be analyzed using standard dynamic programming and linear projection techniques, I develop a deep learning-based algorithm that can handle rich environments featuring both aggregate uncertainty and large numbers of state variables. In addition to solving for particular model equilibria, I show how the deep learning method could be extended to solve for a whole set of models, indexed by the parameters of government policy. By pre-computing the whole equilibrium set, my deep learning method greatly simplifies computation of optimal policies, since it bypasses the need to re-solve the model for many different values of policy parameters.