We study long-time and large-data existence theory of selected recently developed fluid mechanics models suitable for describing the mechanical behavior of materials with complex microstructure. In the first part of this work we focus on the Bingham type models for granular materials with the activation parameter (critical value for the magnitude of the stress) dependent on the internal pore pressure. Our motivation comes from recent research concerning the implicitly constituted materials and also from an interesting paper by Chupin and Mathé [Chupin, Mathé, 2016], where the existence of weak solutions to the given problem was proved only in two spatial dimensions. Here we consider slightly different model (than in [Chupin, Mathé]) that we are able to derive from the basic governing equations of the theory of mixtures and we extend the existence result to three spatial dimensions. In the second part of this work we are concerned with fast developing field of viscoelastic materials. We study long-time and large-data existence of viscoelastic rate-type fluid models of higher order as they represent the simplest models suitable for describing the mechanical behavior of viscoelastic materials with complex microstructure. We are not aware of any long-time and large-data existence results for such models. Motivated by a study by Masmoudi [Masmoudi, 2011], where the proof of the existence of weak solutions to the Giesekus model was briefly sketched, we prove the existence of weak solutions to the second order model, which can be written as a mixture of two Giesekus models, in two spatial dimensions.