Abstract: Understanding the energetic requirements of brain cells during resting state and during high neural activity is a very active research area where mathematical models have contributed significantly by providing a context for the interpretation of the experimental results. We recently proposed novel computational predictive models that connect cerebral electrophysiological activity, cellular metabolism and hemodynamic response via a system of double feedback mechanisms based on energy demand and production. In addition to the difficulty of interfacing the modeling paradigms for the different brain functions, many computational challenges had to be addressed, mostly due to the very different characteristic times at which the electrical, metabolic and hemodynamic events occur. Computed experiments with these models for different protocols, that include awake resting state, transitions between resting state and neural activation and ischemic episodes, as well as cortical spreading depression episodes, show that the model predictions are in good agreement with experimental observations.