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Systems Toxicology of Embryo Development. Knudsen TB. USEPA, ORD, RTP, NC.

An important consideration for predictive toxicology is to identify developmental hazards utilizing mechanism-based *in vitro* assays (e.g., ToxCast) and *in silico* multiscale models. Steady progress has been made with agent-based models that recapitulate morphogenetic drivers for angiogenesis, somitogenesis, urethrogenesis, and palatogenesis. Additional models are underway for the neurovascular unit, endocardial cushions, and neural tube closure. Individually, these models can simulate emergent phenotypes and predict adverse outcomes or 'cybermorphs' to essentially bring an AOP to life utilizing computational dynamics. Collectively, their compilation into an integrated array or 'virtual embryo' motivates the construction of novel ontology systems to integrate molecular pathways, cellular behaviors, and *in vitro* data on chemical-biological interactions with extant knowledge of embryology. *This abstract does not reflect US EPA policy.*