Phage display has unlocked the potential of peptide-based therapeutics and diagnostics. It accelerates the discovery of peptide-derived drugs, some of which have been FDA-approved, and many are progressing through the clinical pipeline. However, the building blocks and diversity of phage libraries is limited to amino acids. Our group uses phage display as a foundation for multi-step organic synthesis to produce libraries of peptide derivatives displayed on phage. We developed the methodology for quantification of yield and purity of reactions on phage-displayed peptide libraries; examples are N-terminal conjugation and cyclization of linear peptides. Chemical modification of libraries allowed us to develop Genetically-Encoded Fragment-Based Discovery (GE-FBD) platform, which combines non-peptide ligands with $>10^8$ variable peptide fragments. For example, GE-FBD can be used to select phage-displayed glycopeptides to dock a glycan fragment at the carbohydrate-binding site and guide selection of synergistic peptide motifs adjacent to the pocket. We believe that display of peptide derivatives on phage can be developed into an efficient platform for discovery of biological probes and drug leads that combine advantages of small-molecule and “biological” classes of drugs.