Organometallic Chemistry bridges the imaginary gap between organic and inorganic chemistry. Despite being a rather new field (Ferrocene 1951), its utility and practicality are undeniable. The production of L-DOPA, S-Metolachlor, and (−)-Menthol are just some of the commodities produced on a colossal scale due to the employment of organometallics catalysts. This class will focus on the entire Periodic Table of Elements and will introduce the fundamental trends in both the Main Group and Transition Metals. Students should gain an understanding of these fundamentals and be able to apply them to published research, with the ultimate goal of applying it to their own! In addition, some topics/complexes will be evaluated from a historical prospective, in which they first appeared as structural anomalies and have evolved (through synthesis, etc.) to become highly useful ligands, intermediates, or catalysts. A common theme throughout the class will be to connect the material from the classroom to relevant and published research, with the hope that students will recognize that although many fields of chemistry (organic, inorganic, physical, supramolecular, etc.) are taught separately, they are interdisciplinary and often times, directly linked by organometallic chemistry.
Topics

Introduction/Historical Perspective
- Landmark compounds and reactions, Evolution of Inorganic/Organometallic Chemistry, Nobel Prize Winners

Main Group
- Structure and Bonding of Groups 1, 2, 13 – 16
- Synthesis of Main Group Compounds
- DOSY NMR spectroscopy
- Reactivity and handling of Main Group Compounds
- Trends in bond strength/length, polarity of M-C bond, comparison to transition metal complexes
- NMR active nuclei (6Li, 7Li, 31P, 19F, etc.) and NMR assignments of complexes
- Inert Pair Effect, increasing energy separation of s/p orbitals
- P- and S-Stereogenic molecules, synthesis and resolution, and importance
- Tolman, Bite Angle, etc. → Describing ligands
- Asymmetric Deprotonation with s-BuLi/(-)-Sparteine
- Carboranes: Synthesis, Reactivity, Applications
- Frustrated Lewis Pairs, NB complexes, other new research
- Unusual, unexpected Main Group complexes

Organometallics to Catalysis
- Introduction: 16/18-electron rule, σ-, π-, and δ-bonding and the orbitals, DCD model, etc.
- Tour of the ligands: σ-donors, σ-donors/π-acceptor, π-donors, common ligands (CO, PR₃, halides, etc.), backbonding and its effect (IR spectroscopy, quantification of electron density)
- Isolobal Analogy and its Application: understanding and predicting bonding, Roald Hoffman (1981 Nobel Prize)
- Reactions at the Metal: Ligand Dissociation/Association, Oxidative Addition/Reductive Elimination, and the impact of steric and electronics
- Reactions involving the Ligands: Insertion/β-hydride elimination, nucleophilic/electrophilic attack, and how to promote or inhibit these processes. Examination of Bredt's Rule, agostic interactions, etc.
- Kinetic Isotope Effects: Deuterium Labeling, Crossover Experiments, etc.
- Homogeneous Catalysis 1: Hydrogenation
- Chirality: Types (Point, planar, axial, helical, etc.), effect of symmetry, examples of chiral molecules
- Asymmetric Catalysis: Hydrogenation and its mechanistic underlyings, prochiral to chiral, how to get enantioinduction, Nobel Prize 2001
- Homogeneous Catalysis 2: Pd-Cross Coupling, Transmetalation Agent (B, Sn, Cu, Si, etc.), 2010 Nobel Prize, Recent Developments (Buchwald Ligands, etc.)
- Homogeneous Catalysis 3: Metathesis, Its development, mechanism, and applications, 2005 Nobel Prize, Dick Schrock/Bob Grubbs, Mo/W vs. Ru
- Future: Hypothetical Directions, what to expect, etc.

Grading

- 5 Brief Exams (80%, 20% each, drop lowest)
- Final (Oral Presentation) → 20% total