- Atomic physics
- Chemical bonds
- Biopolymers
- Information encoding
- Enzymes

- Atoms interact through electromagnetic fields, subject to constraints of quantum mechanics
- Atoms exhibit internal structure:
 - \rightarrow motion of negatively charged electrons (1/1836 amu) defines the "radius" of an atom, e.g., for H the Bohr radius is 53 pm (5.29177210903 × 10⁻¹¹ m)
 - → electrons move around a postively charged nucleus that is much smaller 1.76 fm (1.7566×10^{-15} m), composed of protons (positive charge) and neutrons (neutral charge), and of much higher density (neutrons, protons have mass of 1 amu)
 - → Atom is small enough for quantum mechanics to be the relevant physical theory: particle-wave duality, quantization of electron orbitals characterized by n, l, m (energy, angular momentum, angular momentum vector numbers), $p = \hbar k$, $E = \hbar \omega$, $\lambda = h / p$, $h = 6.626 \times 10^{-34} Js$

$$1s^2 \ 2s^2 \ 2p^6 \ 3s^2 \ 3p^6 \ 4s^2 \ 3d^{10} \ 4p^6$$

- Multiple atoms can reach lower overall energy state by forming bonds
 - $\rightarrow~$ Covalent: sharing of electrons to occupy open slots in orbitals H-H
 - $\rightarrow~$ lonic: electron transfer, electrostatic attraction between ions $\rm Na^+Cl^-$
 - $\rightarrow~$ Metallic: atoms contribute to a sea of electrons, electric conductivity
- Electrostatic force arises from interaction of charges
- Chemical forces arise from imbalances in charge distribution:
 - 1 Ionic
 - 2 Hydrogen
 - 3 Van Der Waals Dipole-Dipole
 - 4 Van Der Waals Dispersion (London)

- Many biological functions are associated with specific polymers
- A polymer is a repeated chemical structure
- Major biopolymers:
 - $\rightarrow \ \text{polysaccharides}$
 - \rightarrow lipids
 - \rightarrow proteins
 - \rightarrow nucleic acids

- Biopolymers encode information
- RNA, DNA are composed of four nucleobases:
 - \rightarrow Adenine
 - \rightarrow Cytosine
 - \rightarrow Guanine
 - \rightarrow Thymine
- A base-4 number is encoded by nucleobase sequence: ... ACCT...
- Organism reproduction arises from DNA replication
- mRNA underlies protein synthesis in the cell

- Chemical reactions depend on random thermal motion and affinity to form new structures
- Reagents can combine more rapidly in the presence of other molecules: catalysts
- Enzymes are biological catalysts