Chemistry 2A (Biological Sciences)
Course Objectives

1. Biopolymers and Biocolloids

- Appreciate the structural principles involved in stabilizing the α-helix and β-pleated sheet conformations of proteins.
- Understand the meaning of a Ramachandran plot and an energy contour diagram of polypeptide conformation.
- Be aware of the different types of intermolecular forces, their relative strengths and relative ranges.
- Appreciate the importance of intermolecular forces in stabilizing the structure of collagen.
- Know the different classes of colloids, be able to give examples of each and appreciate the differences in their thermodynamic stabilities.
- Understand the principles of steric and ionic stabilisation of colloids and the effects of pH and ionic strength.
- Be able to calculate osmotic pressure and appreciate its use in determining the molecular weight of macromolecules.
- Understand the concepts of activity and activity coefficient.

2. Physical Basis of Spectroscopic Methods

- Understand the physical meaning of the wavefunction, ψ, and how discrete energy levels arise from the wave nature of matter.
- Understand the principle of the use of the wave properties of an electron in an electronmicroscope.
- Be able to draw molecular orbital energy level diagrams for simple diatomic molecules (consisting of atoms up to Ne), to determine bond orders and predict paramagnetism.
- Understand how light in the microwave, infra-red and UV/visible range interacts with simple molecules.
- Be able to predict from the shape of simple molecules (i.e. trigonal pyramid, tetrahedral, octahedral, etc.) whether a molecule will be microwave-active, IR-active, UV/visible active or Raman active. Note: This will also require abilities learnt in 1st year in drawing Lewis structures and applying the valence shell electron pair repulsion model (VSEPR) to determine the shape.
- Appreciate some of the information which can be gained from microwave (i.e. bond lengths, bond angles, dipole moments), infrared (i.e. force constants) and UV-visible spectroscopies.
- Be able to interconvert wavelengths, wavenumbers, frequencies and energies.
- Be able to predict the relative frequencies or wavelengths of molecules in the microwave, IR and UV-visible range, i.e. based on their bond lengths, reduced
masses, force constants and bonding structures (i.e. \( \sigma \) and \( \pi \) bonding, and length of \( \pi \)-conjugation).

- Understand qualitatively and quantitatively (via the Boltzmann distribution) the effect of temperature on the intensity of spectroscopic transitions.
- Understand the physical bases of fluorescence, phosphorescence, Rayleigh light scattering and Raman light scattering and how to distinguish between them.
- Understand the reasons for the Stokes shift in fluorescence spectroscopy, i.e. why the emitted light is of lower energy (or longer wavelength) than the exciting light.

3. Principles of Modern Biochemical Analysis

- Understand the principle components of a spectrometer and their functions.
- Know the definitions of absorbance and transmittance, understand the dependence of the absorbance on concentration and pathlength given by the Beer-Lambert law, and be able to apply the Beer-Lambert law in determining concentration.
- Understand the principles of the imaging techniques: fluorescence microscopy and magnetic resonance imaging (MRI).
- Understand the basic principles of atomic emission and atomic absorption spectroscopy.
- Be able to interconvert concentrations in parts per million (ppm) and molarities.
- Be aware of the different types of ionization techniques and understand the different mass analysis techniques in mass spectrometry.
- Understand the principles of immunoassays and appreciate the different methods of detection and their advantages and disadvantages.
- Understand the concept of the electrochemical potential and how concentration differences across a membrane lead to an electrical diffusion potential.
- Understand the relevance of the diffusion potential in biological cells as well as its application in determining ion (including pH) and gas concentrations.