Absorption and Emission

Electronic Transitions

Ground state (S_0) → Excited states (S_1, S_2, ...)

$\Delta E = E_{excited} - E_{ground} = h\nu$

Allowed transitions follow selection rules

Vibrational Modes

Molecular vibrations (stretching, bending)

IR absorption region

Fine structure in spectra

Characteristic frequencies for bonds

Selection Rules

Allowed: $\Delta l = \pm 1$ (dipole transitions)

Spin: $\Delta S = 0$ (singlet-singlet)

Symmetry: Determines intensity

Forbidden: Weak but observable

Stokes Shift

$\lambda_{emission} > \lambda_{excitation}$

Energy loss to vibrations

Typically 20-100 nm shift

Enables fluorescence detection

Quantum Yield (Φ)

Φ = photons emitted / photons absorbed

Range: 0-1 (0-100%)

High Φ → bright fluorophores

GFP: $\Phi \approx 0.79$