Fundamentals of light-matter interaction

Linear interactions

1. Refraction and dispersion
2. Absorption, stimulated and spontaneous emission
3. Polarization in refraction and reflection (Fresnel's formula, Brewster's law, total reflection)
4. Relation between reflection, absorption and refraction
5. Birefringence
6. Optical activity (polarization rotation)
7. Diffraction (Fresnel's and Fraunhofer diffraction, Bragg reflection)
8. Waveguiding (optical fibers)
9. Light scattering (Rayleigh, Mie, Brillouin, Raman, Thomson and Compton)

Nonlinear interactions without absorption

10. Nonresonant interactions
11. Nonlinear polarization of the medium
12. Second-order effects (Sellmeier coefficients, phase matching, second harmonic generation, frequency mixing, Pockels' effect, electro-optical beam deflection)
13. Third-order effects (third harmonic generation, Kerr effect, self-focusing, spatial solitons, Stimulated Brillouin Scattering (SBS), Stimulated Rayleigh Scattering (SRLS), Stimulated Raman Scattering (SRS))

Nonlinear interactions with absorption

14. Homogeneous and inhomogeneous broadening
15. Incoherent interaction (bleaching, transient absorption, nonlinear transmission, spectral hole burning, spatial hole burning)
16. Coherent resonant interaction (density matrix formalism, Feynman diagrams, Rabi oscillation, self-induced transparency)
17. Two-photon and multiphoton absorption
18. Photoionization and optical breakdown
19. Optical damage

Peculiar mechanisms of light tissue interaction

20. Photochemical interactions (photodissociation, photocomposition, photoionisation, photoisomerization, biostimulation)
21. Thermal interactions (photothermolysis, photohyperthermia, photocoagulation, photocarbonization, photovaporization)
22. Photoablation, plasma-induced ablation
23. Photodisruption

Further reading:

- B.E.A. Saleh and M.C. Teich: *Fundamentals of photonics*, 2nd ed. Wiley, 2007
- Ralf Menzel: Photonics: *Linear and nonlinear interactions of laser light and matter*, Springer, 2007