Cells build many complex molecular machines that perform the biological jobs needed for life. Some of these machines are molecular scissors that cut food into digestible pieces. Others then use these pieces to build new molecules when cells grow or tissues need to be repaired. Some molecular machines form sturdy beams that support cells, and others are motors that use energy to crawl along these beams. Some recognize attackers and mobilize defenses against infection.

Researchers around the world are studying these molecules at the atomic level. These 3D structures are freely available at the Protein Data Bank (PDB), the central storehouse of biomolecular structures. A few examples from the ~100,000 structures held in the PDB are shown here, with each atom represented as a small sphere. The enormous range of molecular sizes is illustrated here, from the water molecule (H₂O) with only three atoms (shown at the left) to the ribosomal subunits with hundreds of thousands of atoms.

**Digestive Enzymes:** breaking food into small nutrient molecules
1. Amylase 1smd
2. Phospholipase 1prp
3. Dextranase 1prn
4. Lysozyme 1cki
5. Pepsin 5pep
6. Trypsin 2ptc
7. Carboxypeptidase 5rsa
8. Ribonuclease 1gfl

**Blood Plasma Proteins:** transporting nutrients and defending against injury
9. Factor X 1xka, 1iod
10. Thrombin 1ppb
11. Fibrin 1m1j, 2baf
12. Serum Albumin 1smd
13. Antibody 1igg
14. Rhodopsin 1cvp
15. Glucagon 1gcn
16. Insulin 2hiu
17. Epidermal Growth Factor 1gfi
18. Ras Protein 5pep
19. Beta-Adrenergic Receptor/Go Protein 3a3096
20. Atrial Natriuretic Peptide 2bpg
21. Epidermal Growth Factor Receptor 1wv, 2wv, 2w6p
22. Retinoblastoma 1koi
23. Polyproteins 4m2t
24. Potassium Channel 1su4
25. Calcium Pump 1sos
26. Cysteine protease 1pcp

**Viruses and Antibodies:** engaging in constant battle in the bloodstream
19. Rhinovirus 1wvs
20. Acellular Vaccine 2gls
21. Epidermal Growth Factor Receptor 1gfi
22. Epidermal Growth Factor 1igg
23. Retinoblastoma 1koi
24. Calmodulin 3wbf
25. Ribonuclease 1gfl
26. Cysteine protease 1pcp

**Hormones:** carrying molecular messages through blood
15. Glucagon 1gcn
16. Insulin 2hiu
17. Epidermal Growth Factor 1gfi
18. Ras Protein 5pep
19. Beta-Adrenergic Receptor/Go Protein 3a3096
20. Atrial Natriuretic Peptide 2bpg
21. Epidermal Growth Factor Receptor 1wv, 2wv, 2w6p
22. Retinoblastoma 1koi
23. Polyproteins 4m2t
24. Potassium Channel 1su4
25. Calcium Pump 1sos
26. Cysteine protease 1pcp

**Channels, Pumps and Receptors:** getting back and forth across the membrane
18. Ras Protein 5pep
19. Beta-Adrenergic Receptor/Go Protein 3a3096
20. Atrial Natriuretic Peptide 2bpg
21. Epidermal Growth Factor Receptor 1wv, 2wv, 2w6p
22. Retinoblastoma 1koi
23. Polyproteins 4m2t
24. Potassium Channel 1su4
25. Calcium Pump 1sos
26. Cysteine protease 1pcp

**Photosynthesis:** harvesting energy from the sun
27. Photosystem II 1s1l
28. Light-harvesting Complex 1wv
29. Photosynthetic Reaction Center 1pcp

**Enzymes:** cutting and joining the molecules of life
39. Fatty Acid Synthase 2wob, 2wve
40. Rubisco: Ribulose Bisphosphate Carboxylase/Oxygenase 1rcx
41. Green Fluorescent Protein 1gfl
42. Luciferase 2hiu
43. Glutamine Synthetase 2pik
44. Alcohol Dehydrogenase 2wob
45. Alcohol Dehydrogenase Reductase 1dfl
46. Nitrogenase 1rzc
47. Lactate Dehydrogenase 1lap
48. Beta-Lactamase 4blm
49. Catalase 1hox
50. Thymidylate Synthase 2bnc
51. Tyrosine Synthase 1wey
52. Aspartate Carboxyltransferase 4at1
53. Hexokinase 1dpk
54. Phosphoglucomutase 1hox
55. Phosphoglucomutase 4pfl
56. Aldolase 4dfd
57. Triosephosphate Isomerase 2yph
58. Glycolaldehyde 3-phosphate Dehydrogenase 3pdr
59. Phosphoglycerate Kinase 3pik
60. Phosphoglycerate Mutase 3pgm
61. Isocitrate 1sw
62. Pyruvate Kinase 1a3w

**Energy Production:** powering the processes of the cell
30. Cytochrome c Oxidase (Complex IV) 1oco
31. Cytochrome c 3cyt
32. Cytochrome bc1 (Complex III) 1bgy
33. Succinate Dehydrogenase (Complex II) 1enk
34. NADH-Oxidase (Complex I) 1m9d, 1sko
35. ATP Synthase 1enl, 1c17, 1l2p, 2a7u
36. Myoglobin 1ebs
37. Hemoglobin 4gbb

**Storage:** containing nutrients for future consumption
38. Ferritin 1hrs
39. Fatty Acid Synthase 2gls
40. Potassium Channel 1sos
41. Cysteine protease 1pcp
42. Retinoblastoma 1koi
43. Calmodulin 3wbf
44. Ribonuclease 1gfl
45. Cysteine protease 1pcp
46. Retinoblastoma 1koi
47. Potassium Channel 1sos
48. Calcium Pump 1sos
49. Cysteine protease 1pcp
50. Retinoblastoma 1koi
51. Ribonuclease 1gfl