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RCSB PDB PROTEIN DATA BANK

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# Molecular Machinery:

## A Tour of the Protein Data Bank

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.

Adenosine Triphosphate (ATP)

Glucose

Water

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 ($H_2O$) 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 1poe
3. Deoxyribonuclease 2dnj
4. Lysozyme 1lz1
5. Pepsin 5pep
6. Trypsin 2ptc
7. Carboxypeptidase 3cpa
8. Ribonuclease 5rsa

**Blood Plasma Proteins:** transporting nutrients and defending against injury

9. Factor X 1xka, 1iod
10. Thrombin 1ppb
11. Fibrin 1m1j, 2baf
12. Serum Albumin 1e7i

**Viruses and Antibodies:** engaging in constant battle in the bloodstream

13. Antibody 1igt
14. Rhinovirus 4rhv

**Hormones:** carrying molecular messages through blood

15. Glucagon 1gcn
16. Insulin 2hiu
17. Epidermal Growth Factor 1egf

**Channels, Pumps and Receptors:** getting back and forth across the membrane

18. Ras Protein 5p21
19. Beta2-Adrenergic Receptor/Gs Protein 3sn6
20. Acetylcholine Receptor 2bg9
21. Epidermal Growth Factor Receptor 1ivo, 2jwa, 2gs6
22. Rhodopsin 1f88
23. P-glycoprotein 4m2t
24. Potassium Channel 3lut
25. Calcium Pump 1su4
26. Cyclooxygenase 1prh

**Photosynthesis:** harvesting energy from the sun

27. Photosystem II 1s5l
28. Light-harvesting Complex 1rwt
29. Photosynthetic Reaction Center 1prc

**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) 1nek
34. NADH-Quinone Oxidoreductase (Complex I) 3m9s, 3rko
35. ATP Synthase 1e79, 1c17, 1l2p, 2a7u
36. Myoglobin 1mbd
37. Hemoglobin 4hhb

**Storage:** containing nutrients for future consumption

38. Ferritin 1hrs

**Enzymes:** cutting and joining the molecules of life

39. Fatty Acid Synthase 2uvb, 2uvc
40. RuBisCo: Ribulose Bisphosphate Carboxylase/Oxygenase 1rcx
41. Green Fluorescent Protein 1gfl
42. Luciferase 2d1s
43. Glutamine Synthetase 2gls
44. Alcohol Dehydrogenase 2ohx
45. Dihydrofolate Reductase 1dhf
46. Nitrogenase 1n2c
47. Leucine Aminopeptidase 1lap
48. Beta-Lactamase 4blm
49. Catalase 1qqw
50. Thymidylate Synthase 2tsc
51. Tryptophan Synthase 1wsy
52. Aspartate Carbamoyltransferase 4at1
53. Hexokinase 1dgk
54. Phosphoglucose Isomerase 1hox
55. Phosphofructokinase 4pfk
56. Aldolase 4ald
57. Triosephosphate Isomerase 2ypi
58. Glyceraldehyde-3-phosphate Dehydrogenase 3gpd
59. Phosphoglycerate Kinase 3pgk
60. Phospoglycerate Mutase 3pgm
61. Enolase 5enl
62. Pyruvate Kinase 1a3w

Scale:

1nm 5nm 10nm

1nm (nanometer) = $10^{-6}$ millimeters

Extracellular Proteins | Membrane Proteins | Intracellular Proteins: Cytosol