

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.

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 at a magnification of about 3,500,000 times, 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 1poe
3. Deoxyribonuclease 2dnj
4. Lysozyme 1lzt
5. Pepsin 5pdp
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 1rvt
29. Photosynthetic Reaction Center 1prc

Scale:

1nm 5nm 10nm

1nm (nanometer) =

10⁶ millimeters

10⁹ micrometers

10¹² nanometers

10¹⁵ picometers

10¹⁸ femtometers

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