JCVI-syn3A is a minimal cell developed at the J. Craig Venter Institute, with a reduced genome of 493 genes. It was developed in several steps, starting from Mycoplasma mycoides and successively removing non-essential genes. In the most recent step, from Syn3.0 to Syn3A, 19 genes were added back to the cell resulting in more stable morphology and division of the cells. Syn3A cells provide an attractive laboratory for exploring the central processes needed for life and abundant information is available for them, including an extensively-annotated genome, a proteome with molecular abundances, and cryo-EM images of individual cells. The illustration integrates this experimental data to create a cross-section through an entire JCVI-syn3A cell, showing all macromolecules.

doi: 10.2210/rcsb_pdb/goodsell-gallery-042

Learn more: pdb101.rcsb.org
MOLECULAR LANDSCAPES

This calendar celebrates the watercolor paintings of David S. Goodsell that integrate information from structural biology, microscopy, and biophysics to simulate detailed views of the molecular structure of living cells.

The images herein are drawn from more than 40 illustrations available from PDB-101 in a special SciArt Digital Archive. These illustrations are free for use under the CC-BY-4.0 license.

PDB-101 is also the proud host of the Irving Geis Digital Archive. Geis (1908-1997) was a visionary artist who helped illuminate the field of structural biology with his iconic images of DNA, hemoglobin, and other important macromolecules. Through a collaboration with the Howard Hughes Medical Institute (HHMI), which owns the Geis Archives, PDB-101 displays many of his illustrations in the context of the corresponding PDB structures and related molecular information. Through PDB-101, these images are available for download for noncommercial usage.

David Goodsell is the creator of the PDB-101 Molecule of the Month series. Since 2000, these articles have introduced millions of visitors to stories about molecular structure and function, their diverse roles within living cells, and the growing connections between biology and nanotechnology.

Both SciArt galleries link to relevant Molecule of the Month articles for further exploration.

Visit PDB-101 (pdb101.rcsb.org) to access SciArt galleries, award-winning images, videos, and other educational and outreach resources.
The cover image (left) is a cross-section of an *Escherichia coli* cell. It shows the characteristic two-membrane cell wall of gram-negative bacteria (green), with a large flagellar motor spanning the entire wall. The genome forms a loosely-defined “nucleoid” (yellow) and interacts with many DNA-binding proteins (tan and orange). Many soluble macromolecules occupy the space around the nucleoid, including ribosomes (reddish purple), enzymes (blue), and L-shaped transfer RNAs (pink).

**Escherichia coli Bacterium**
1999
doi: 10.2210/rcsb_pdb/goodsell-gallery-001

The cover illustration is an update of an earlier *E. coli* painting from 1999 (shown above), incorporating abundant new data that has been gathered since then, including proteomics information and many amazing new structures. A few notable molecular systems are highlighted at PDB-101.

**Escherichia coli Bacterium**
2022
doi: 10.2210/rcsb_pdb/goodsell-gallery-028

About the Cover
JCVI-syn3A Minimal Cell

JCVI-syn3A is a minimal cell developed at the J. Craig Venter Institute, with a reduced genome of 493 genes. It was developed in several steps, starting from Mycoplasma mycoides and successively removing non-essential genes. In the most recent step, from Syn3.0 to Syn3A, 19 genes were added back to the cell resulting in more stable morphology and division of the cells. Syn3A cells provide an attractive laboratory for exploring the central processes needed for life and abundant information is available for them, including an extensively-annotated genome, a proteome with molecular abundances, and cryo-EM images of individual cells. The illustration integrates this experimental data to create a cross-section through an entire JCVI-syn3A cell, showing all macromolecules.

doi: 10.2210/rcsb_pdb/goodsell-gallery-042

Learn more: pdb101.rcsb.org
JCVI-syn3A Minimal Cell

2022

JCVI-syn3A is a minimal cell created at the J. Craig Venter Institute by removing non-essential genes from a small bacterium. Because it is such a small cell, this illustration includes every protein and RNA encoded in its genome. The cell membrane is in green, the DNA and associated proteins in yellow and orange, ribosomes and RNA in magenta, and soluble proteins in blue.

doi: 10.2210/rcsb_pdb/goodsell-gallery-042

Learn more: pdb101.rcsb.org
This painting shows a cross section through a SARS-CoV-2 virion surrounded by blood plasma, with neutralizing antibodies in bright yellow. The painting was commissioned for the cover of a special COVID-19 issue of *Nature* in 2020 and is currently in the Cultural Programs collection of the National Academy of Sciences.

*doi: 10.2210/rcsb_pdb/goodsell-gallery-025*

Learn more: pdb101.rcsb.org
Casein Micelle and Fat Globule in Milk

2021

A casein micelle (tan) from cow’s milk includes many unstructured alpha and beta casein chains interacting with small calcium phosphate nanoclusters (white), and kappa casein chains extending from the surface. A fat globule (left) is surrounded by a multi-layered membrane with many embedded proteins, filled with fat molecules (yellow) and a few carotene molecules (orange). Whey proteins are shown in darker shades around the micelle.

doi: 10.2210/rcsb_pdb/goodsell-gallery-039

Learn more: pdb101.rcsb.org
Cellulose Synthase

2021

Two cellulose synthase complexes (green) are building cellulose fibers (tan) outside a plant cell. Other structural molecules of the cell wall, including xyloglucans and pectins (darker brown), fill the spaces between the cellulose fibers. A microtubule (blue) is aligned just inside the membrane (light green), and guides the direction that cellulose fibers are built.

doi: 10.2210/rcsb_pdb/goodsell-gallery-029

Learn more: pdb101.rcsb.org
Many nerve axons in the central nervous system are surrounded by an insulating coat of myelin. An axon is shown at the left, with the membrane in green, the cytoplasm and cytoskeleton in blue, and a mitochondrion in purple and magenta. An oligodendrocyte wraps multiple times around the axon, shown with the membrane and membrane-bound proteins in yellow and the cytoplasm and cytoskeleton in orange.

Myelin
2020

doi: 10.2210/rcsb_pdb/goodsell-gallery-030

Learn more: pdb101.rcsb.org
Lipids such as fats and cholesterol are stored in large droplets inside cells. The lipids (yellow) are inserted between the two leaflets of a lipid bilayer of the endoplasmic reticulum (running diagonally through the picture), and the droplet buds out from the surface. The protein seipin, seen at the narrow connection between the lower droplet and the ER, assists the budding process.

doi: 10.2210/rcsb_pdb/goodsell-gallery-017

Learn more: pdb101.rcsb.org
This speculative painting depicts the Last Universal Common Ancestor, or LUCA, the primordial cell that gave rise to all life on Earth. The cell is shown in the process of dividing, with a simple set of proteins that segregate the two copies of the DNA into the two new daughter cells. The depicted molecules were reconstructed by looking for commonalities among existing modern bacteria.

*Last Universal Common Ancestor*

2018

This speculative painting depicts the Last Universal Common Ancestor, or LUCA, the primordial cell that gave rise to all life on Earth. The cell is shown in the process of dividing, with a simple set of proteins that segregate the two copies of the DNA into the two new daughter cells. The depicted molecules were reconstructed by looking for commonalities among existing modern bacteria.

*doi: 10.2210/rcsb_pdb/goodsell-gallery-035*

Learn more: pdb101.rcsb.org
Excitatory Synapse
2018

Nerve signals are passed from cell to cell across synapses. Here, a synaptic vesicle (yellow) is releasing the glutamate neurotransmitter into the synapse. It diffuses across the small gap and binds to glutamate receptors on the neighboring cell at right, causing it to send its own signal.

doi: 10.2210/rcsb_pdb/goodsell-gallery-016

Learn more: pdb101.rcsb.org
RecA and DNA

RecA protein (turquoise) associates with DNA and forms a long, thin filament that stretches through a cell, providing a scaffold to assist with the pairing of homologous strands during DNA repair. Here, several sites in the DNA are temporarily pairing with the RecA DNA filament as the filament searches for an exact pairing.

doi: 10.2210/rcsb_pdb/goodsell-gallery-038

Learn more: pdb101.rcsb.org
Autophagy

Cells engulf obsolete or damaged portions of themselves using the process of autophagy. Small lipid vesicles (gray blue) are budding from the Golgi at upper right and forming an autophagosome at lower left, which is engulfing a large, spherical aggregate of the lysosomal enzyme aminopeptidase (turquoise).

doi: 10.2210/rcsb_pdb/goodsell-gallery-012

Learn more: pdb101.rcsb.org
Myoglobin in a Whale Muscle Cell

2021

Whale muscles contain many myoglobin molecules (red) to store oxygen during their deep dives. Much of this myoglobin is found between the actin and myosin filaments that power muscle contraction (yellow and tan). Energy production enzymes (blue) and glycogen granules (purple) are also found in this space. A tubule of the sarcoplasmic reticulum is shown at the bottom with proteins that concentrate calcium inside, for use in controlling muscle contraction.

doi: 10.2210/rcsb_pdb/goodsell-gallery-032

Learn more: pdb101.rcsb.org
Transfer RNA and Gag Protein

2021

HIV-1 Gag polyprotein (magenta) captures the viral genomic RNA (long snaky molecule in magenta) and powers the budding of the virus from the surface of infected cells. Recent work shows that it binds to transfer RNA and ribosomes in the cytoplasm, forming a reservoir of Gag molecules that are used during assembly and budding of new virions.

doi: 10.2210/rcsb_pdb/goodsell-gallery-037

Learn more: pdb101.rcsb.org
Cells rely on many large molecular machines that carry out the complex biological and chemical tasks responsible for sustaining life. 3D structures of these machines are freely available at the Protein Data Bank (PDB), the global storehouse of biomolecular structures central to research and education. RCSB.ORG serves millions of users worldwide each year, providing services that

- Inform basic and applied research across the sciences
- Are central to understanding human, animal, and plant health and disease
- Are critical for drug discovery/development and biotechnology
- Enable education across biology and medicine

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REFERENCES


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