



The Nobel Prize in Chemistry 2009

"for studies of the structure and function of the ribosome"



Photo: MRC Laboratory of
Molecular Biology

**Venkatraman
Ramakrishnan**



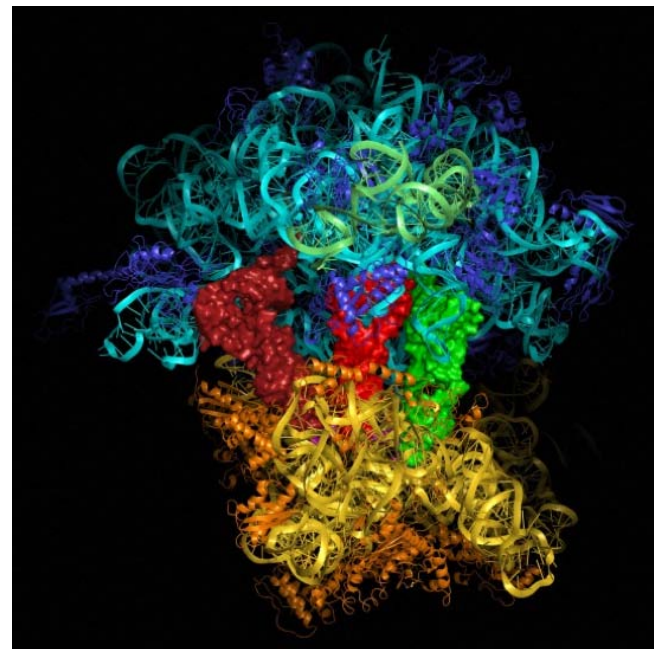
Credits: Michael Marsland/Yale
University

Thomas A. Steitz



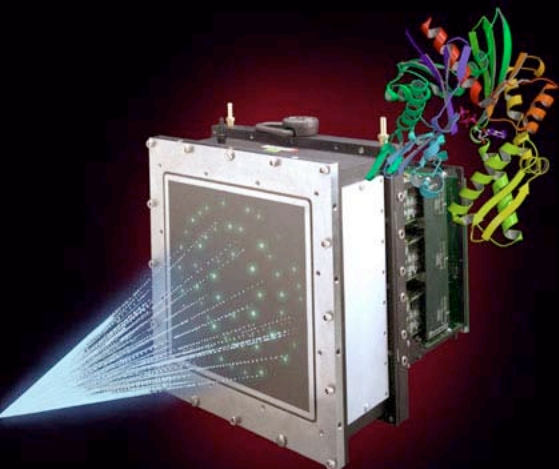
Credits: Micheline
Pelletier/Corbis

Ada E. Yonath





The Nobel Prize in Physics 2009



"for groundbreaking achievements concerning the transmission of light in fibers for optical communication"

"for the invention of an imaging semiconductor circuit – the CCD sensor"

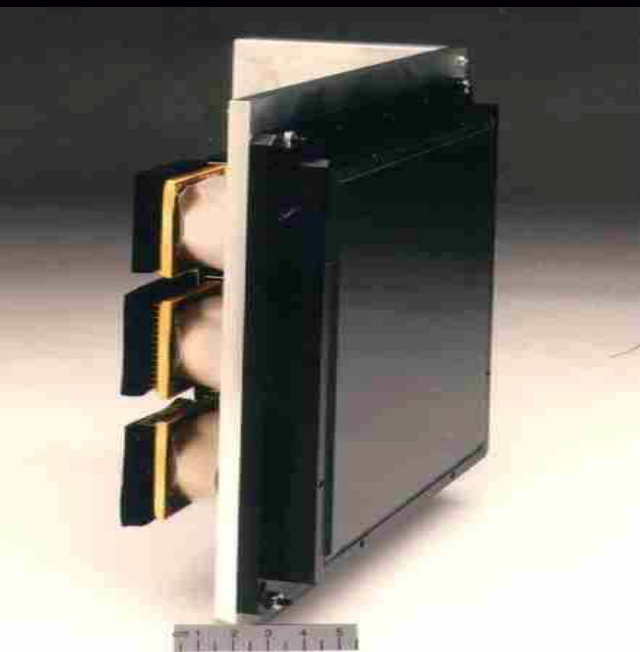
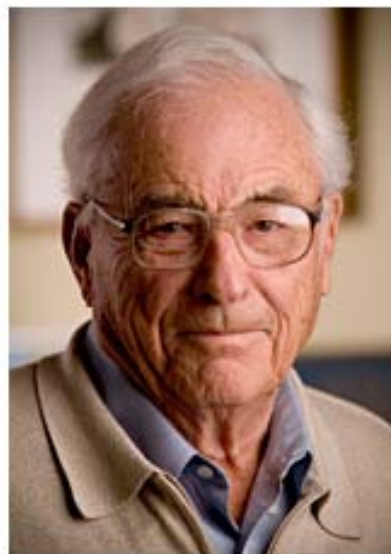


Photo: Richard Epworth

Charles K. Kao



Copyright © National Academy of Engineering

Willard S. Boyle



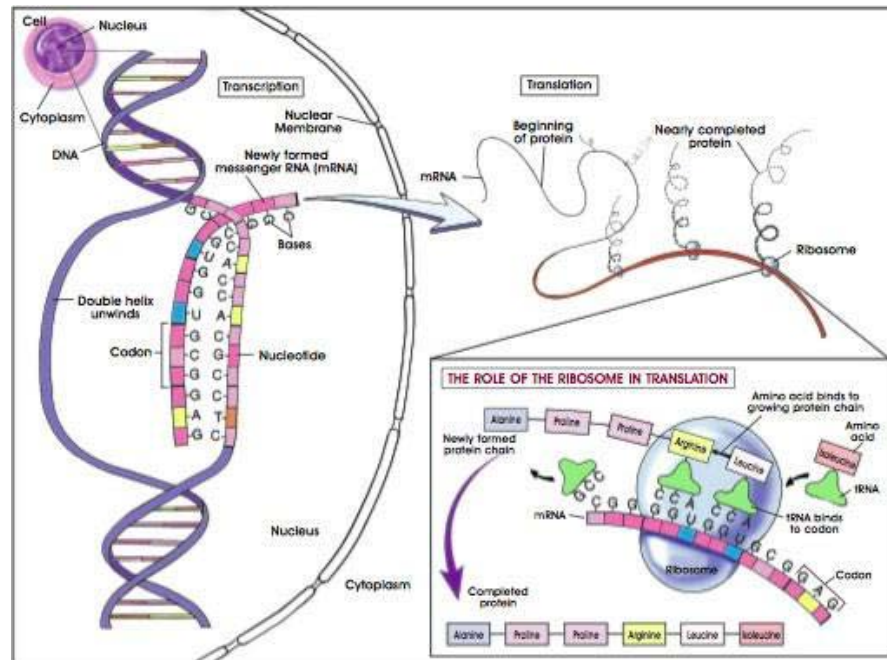
Copyright © National Academy of Engineering

George E. Smith



Ribosome Function

- One of the central tenets of biology is that DNA makes RNA, which then makes protein.
- The DNA sequence in genes is copied into a messenger RNA (mRNA). Ribosomes read the information in mRNA and produce proteins.

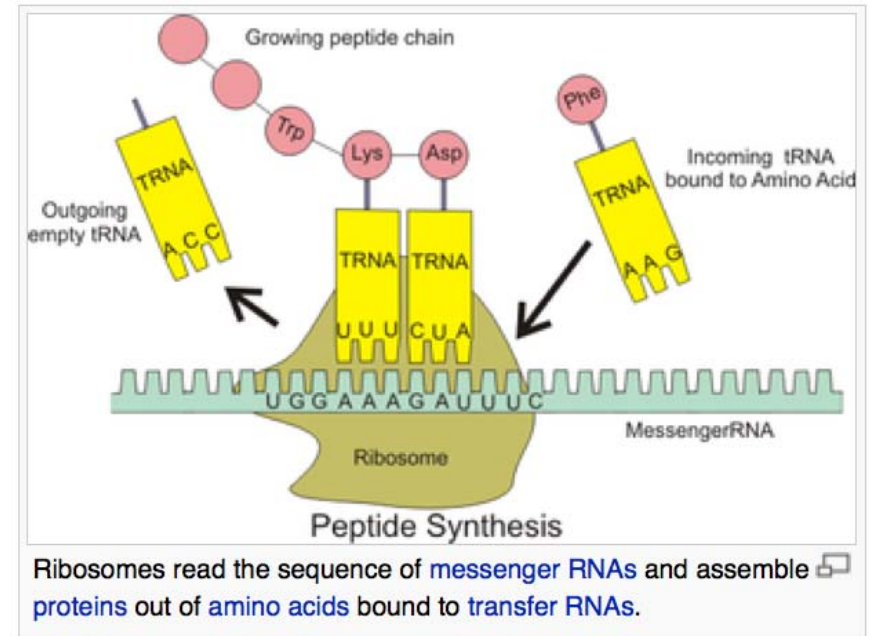


- The word ribosome comes from ribonucleic acid and the Greek: soma (meaning body).



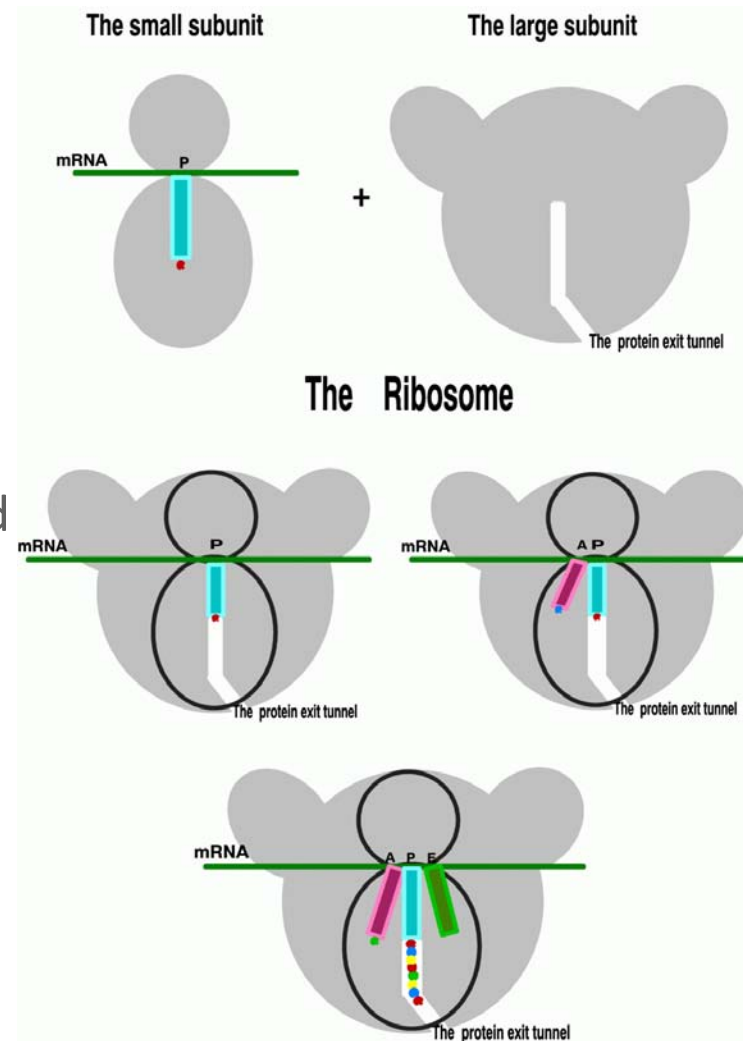
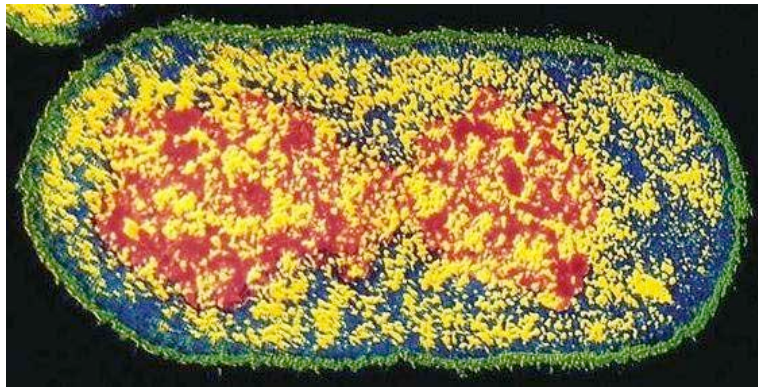
Ribosome Function

- Ribosomes do this by binding to a messenger RNA and using it as a template for the correct sequence of amino acids in a particular protein.
- The amino acids are attached to transfer RNA (tRNA) molecules. The attached amino acids are then joined together to form polypeptide.
- The ribosome moves along the mRNA, "reading" its sequence and producing a chain of amino acids.

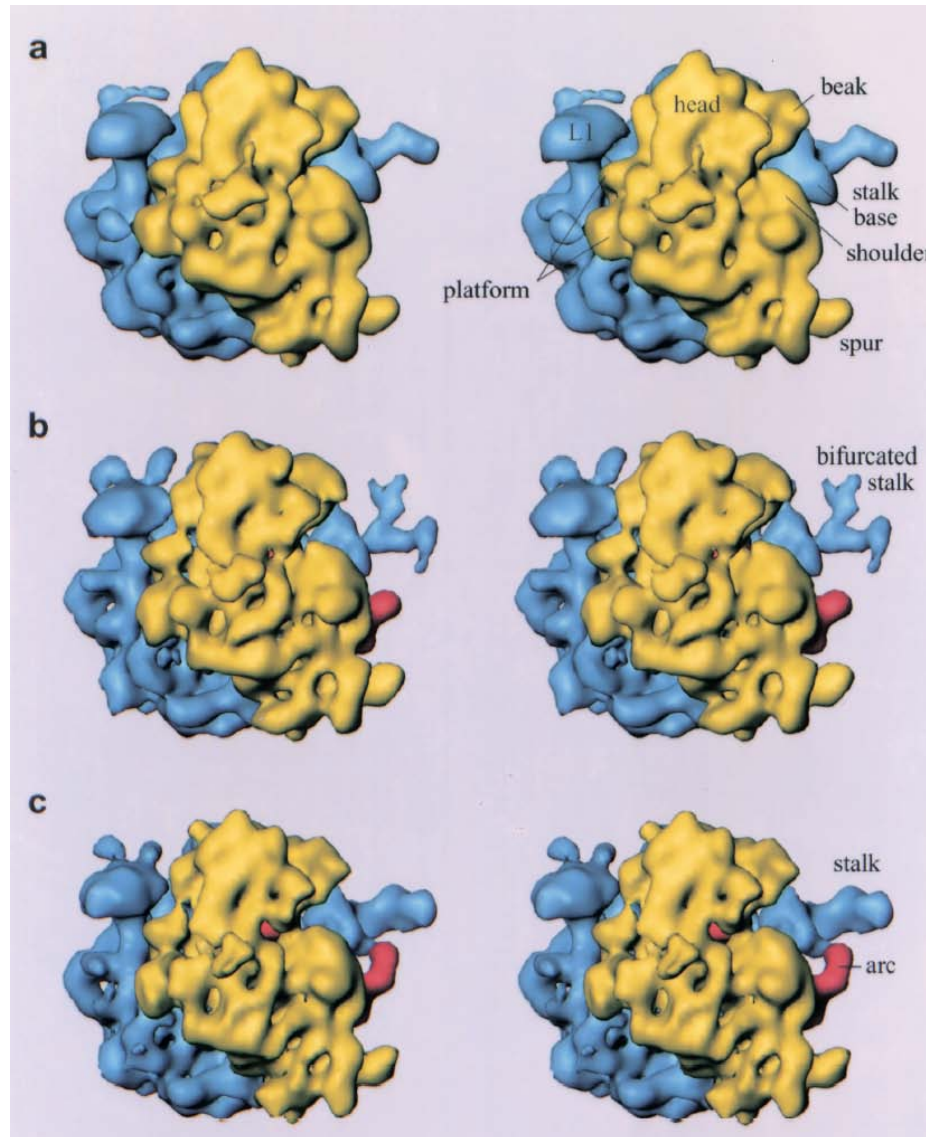


Ribosome

- Ribosome is an assembly of 3 RNAs and ~54 proteins.
- Ribosomes are divided into two subunits, one larger 50S (1.5 MDa) and smaller 30S (~0.8 MDa) .
- The 30S subunit binds initiation factors and mRNA,
- The 50S subunit binds the aminoacy-tRNAs and is catalytic center of the the peptidyl transferase.



Cryo-EM Structure of Ribosome

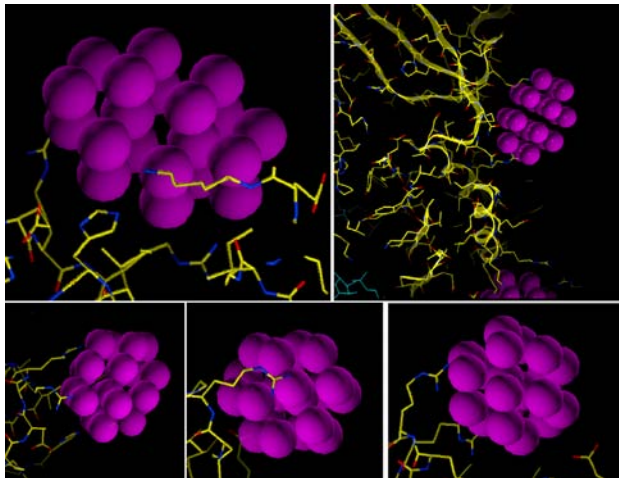
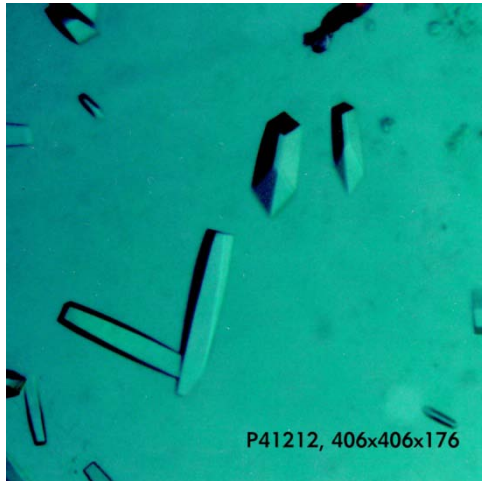


Ribosome is a Ribozyme

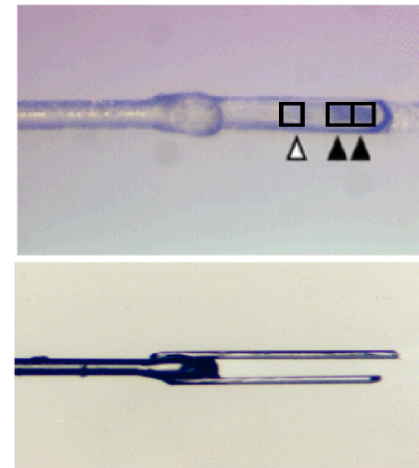
- Ribosomes have been classified as ribozymes, since the ribosomal RNA seems to be most important for the peptidyl transferase activity that links together amino acids.
- Ribosomes from bacteria, archaea and have significantly different structure and RNA sequences. These structural allow some antibiotics to kill bacteria by inhibiting their ribosomes, while leaving human ribosomes unaffected.



Synchrotron X-ray Sources Were Critical for Structure Determination of Ribosome

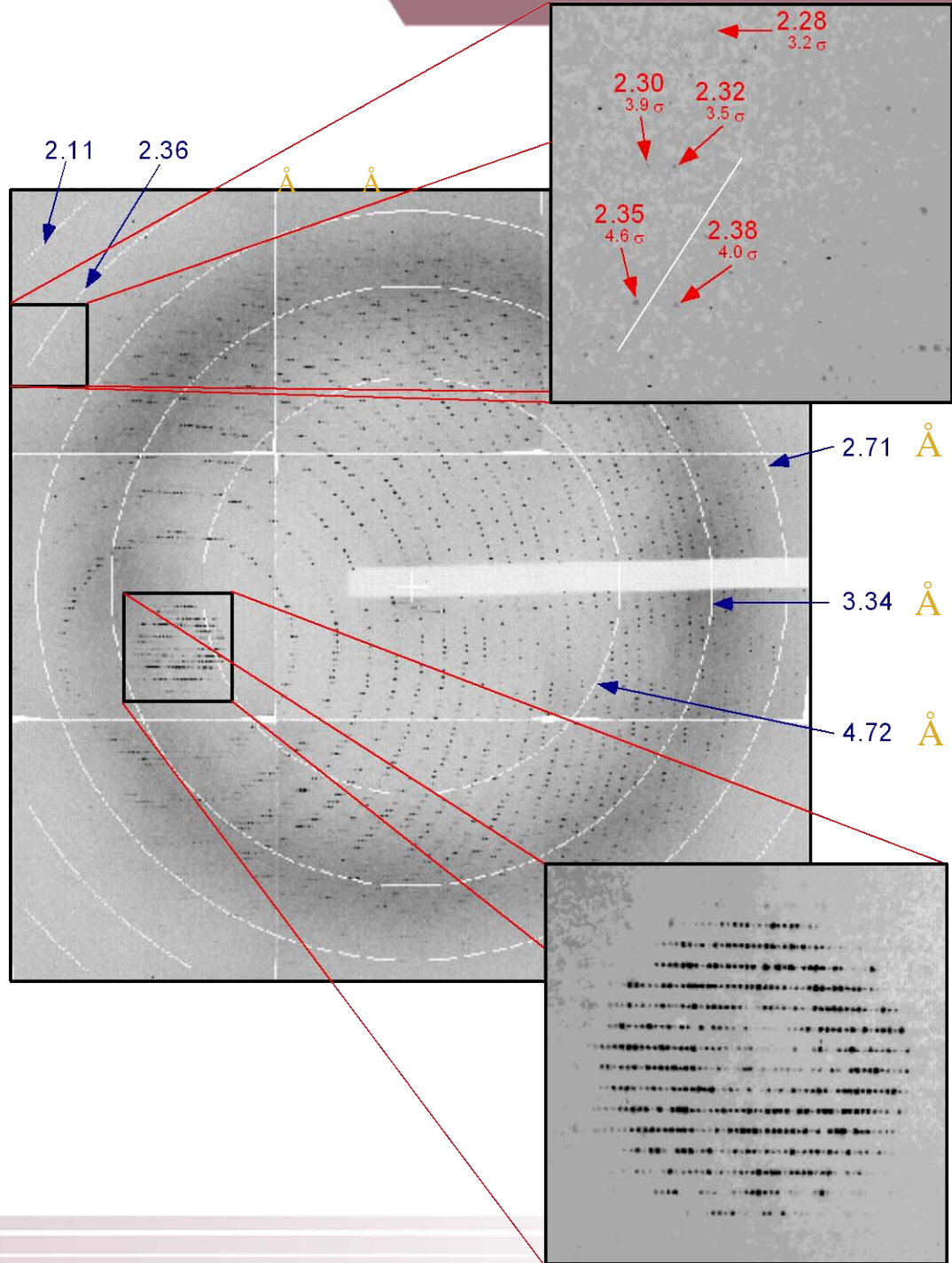


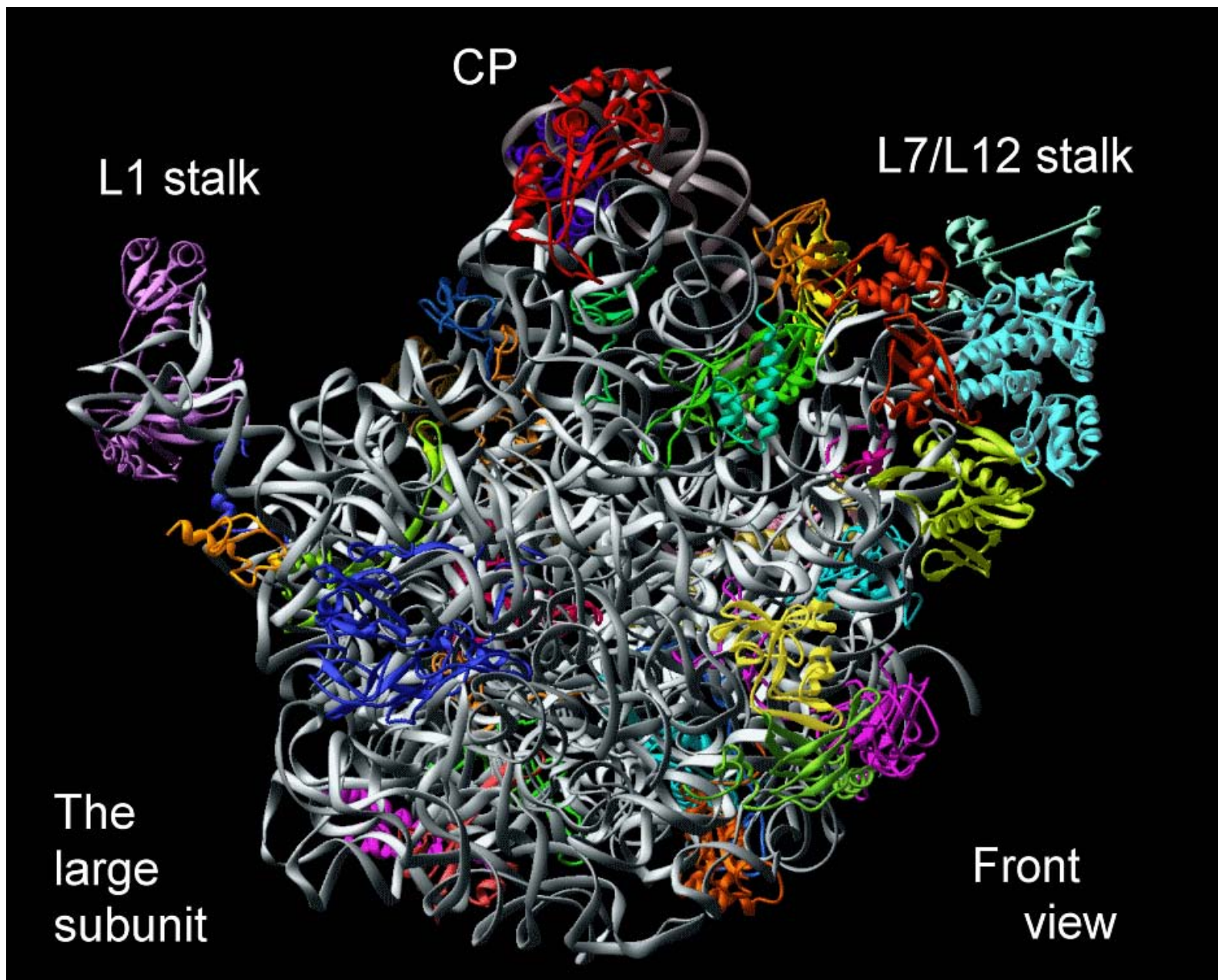
Maximizing the amount of data collected from a single crystal that decays fast under irradiation



Crystal holder (spatulum)

Diffraction from 50S ribosomal subunit

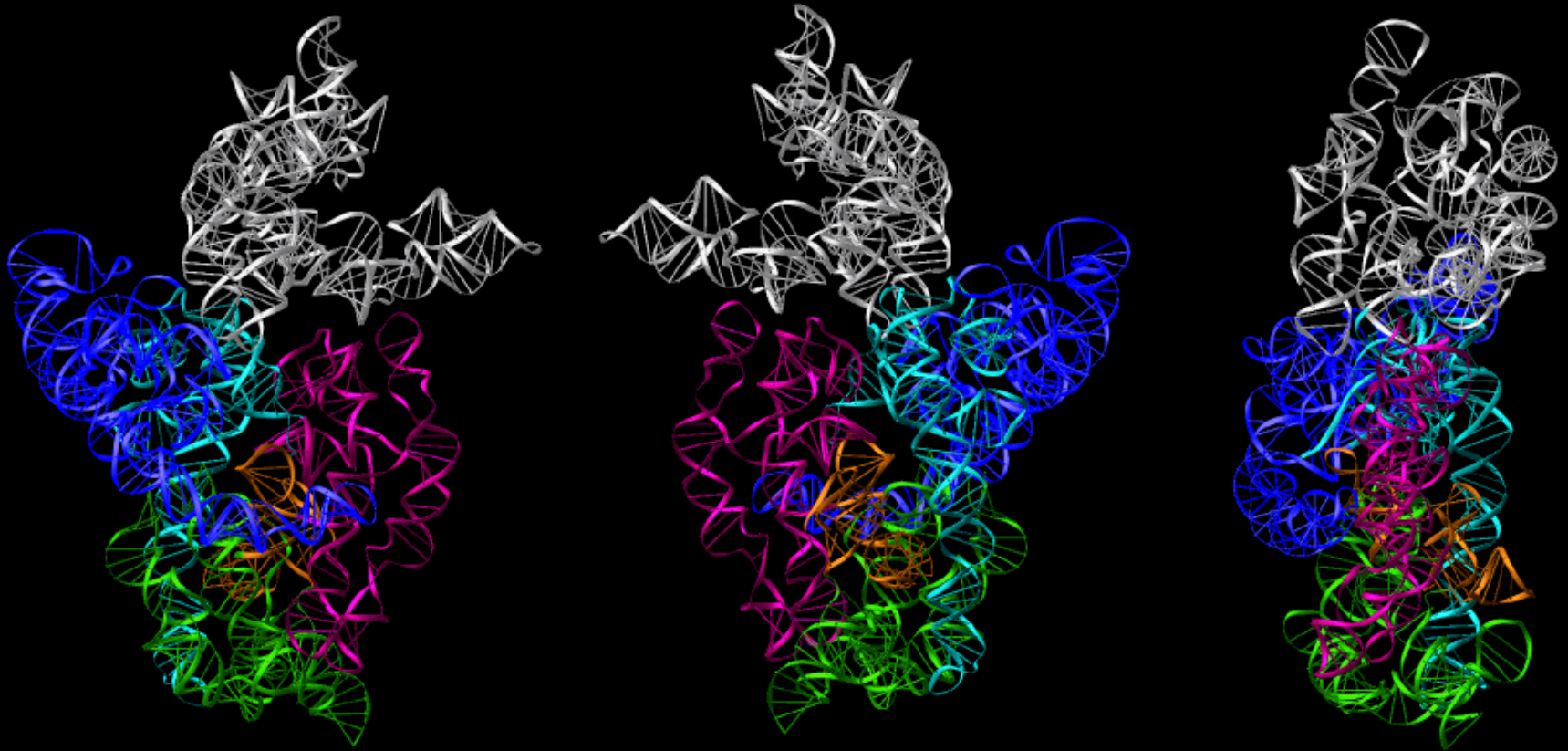




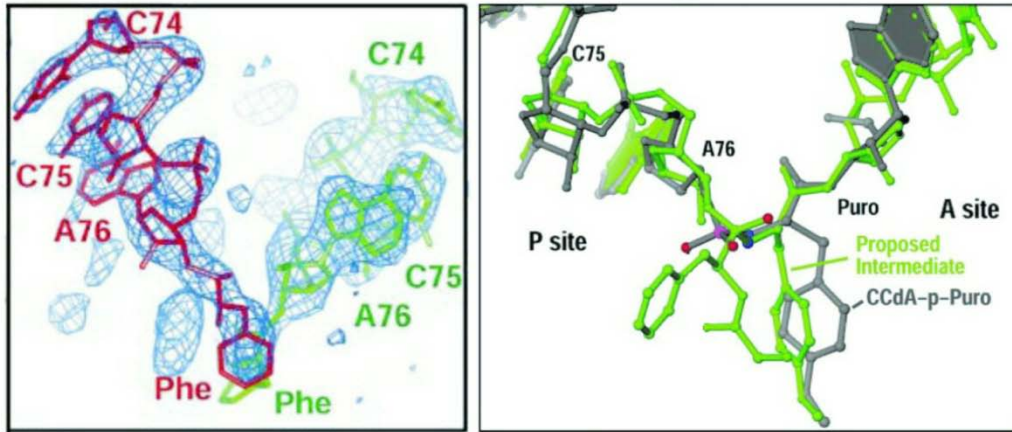
30S Subunit



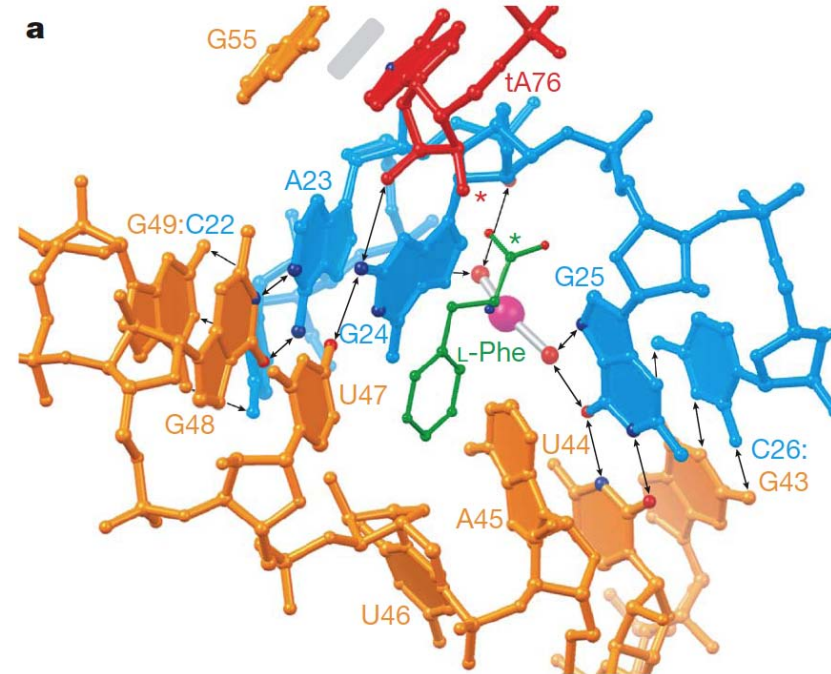
30S RNA domains



Active Site



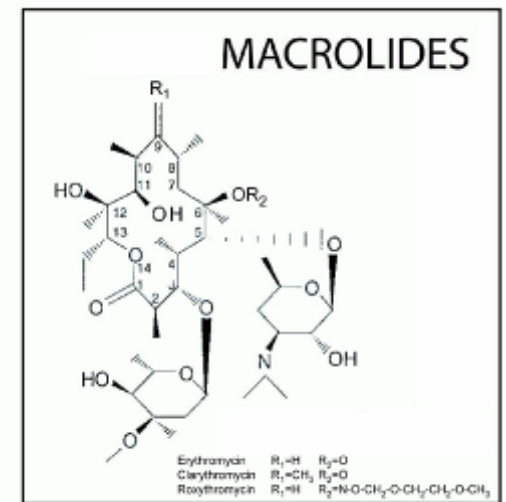
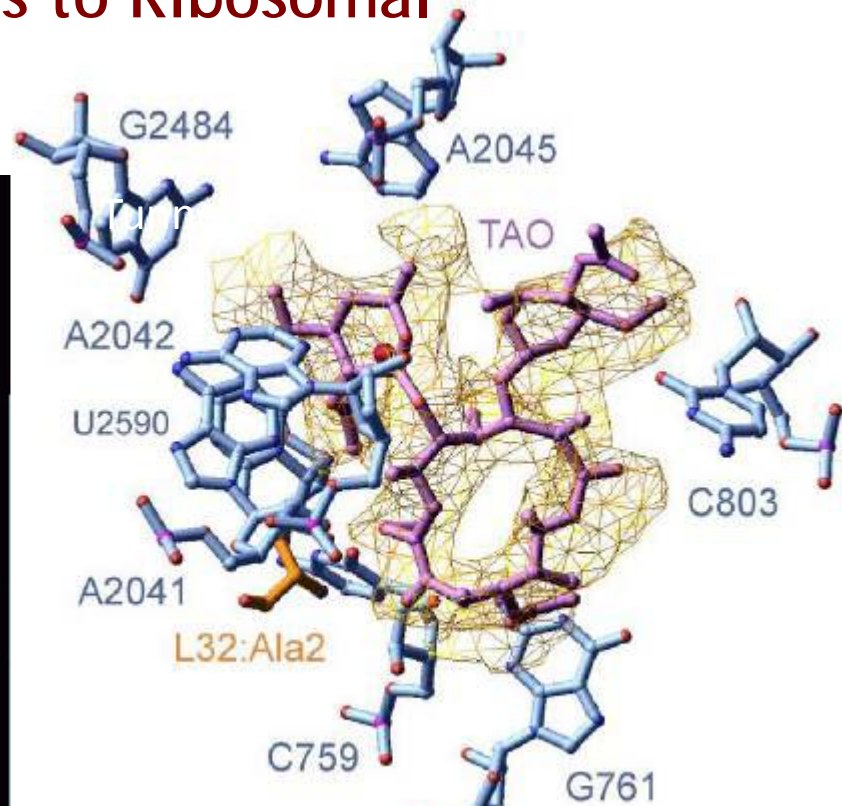
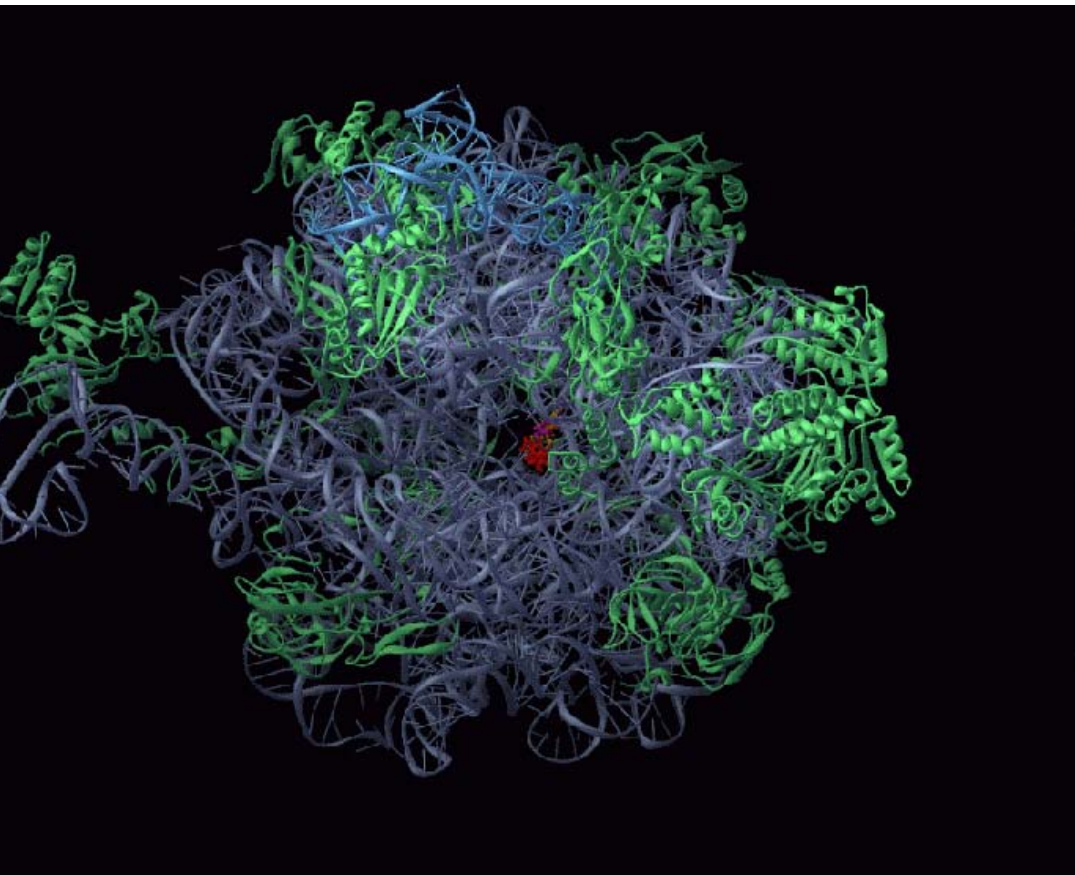
It would appear that additional conformational changes in either the ribosome or the substrates would be required to enable the formation of a new peptide bond once substrates are bound to the ribosome, as observed.



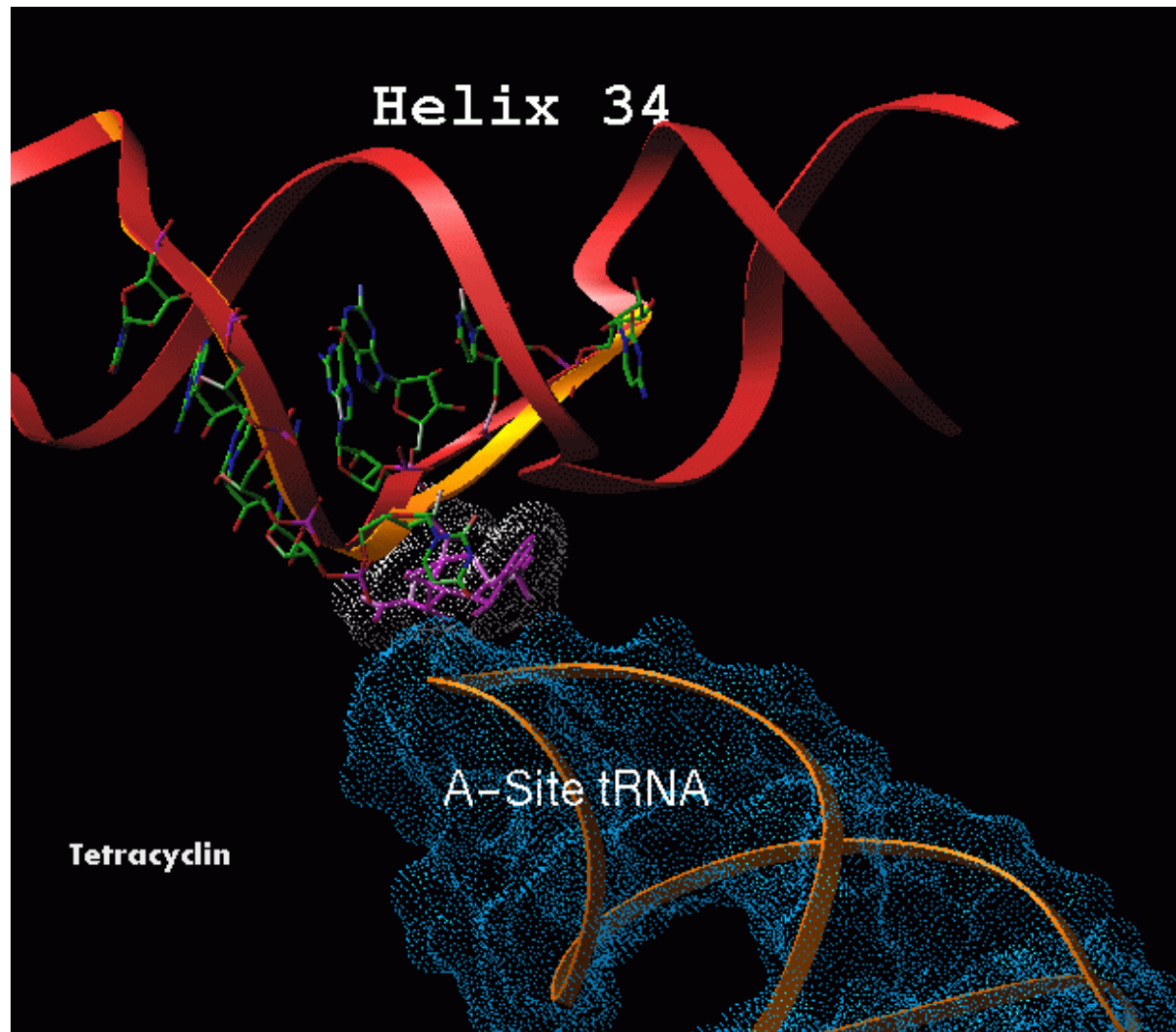
Hansen et al., PNAS September 3, 2002 vol. 99 no. 18 11673



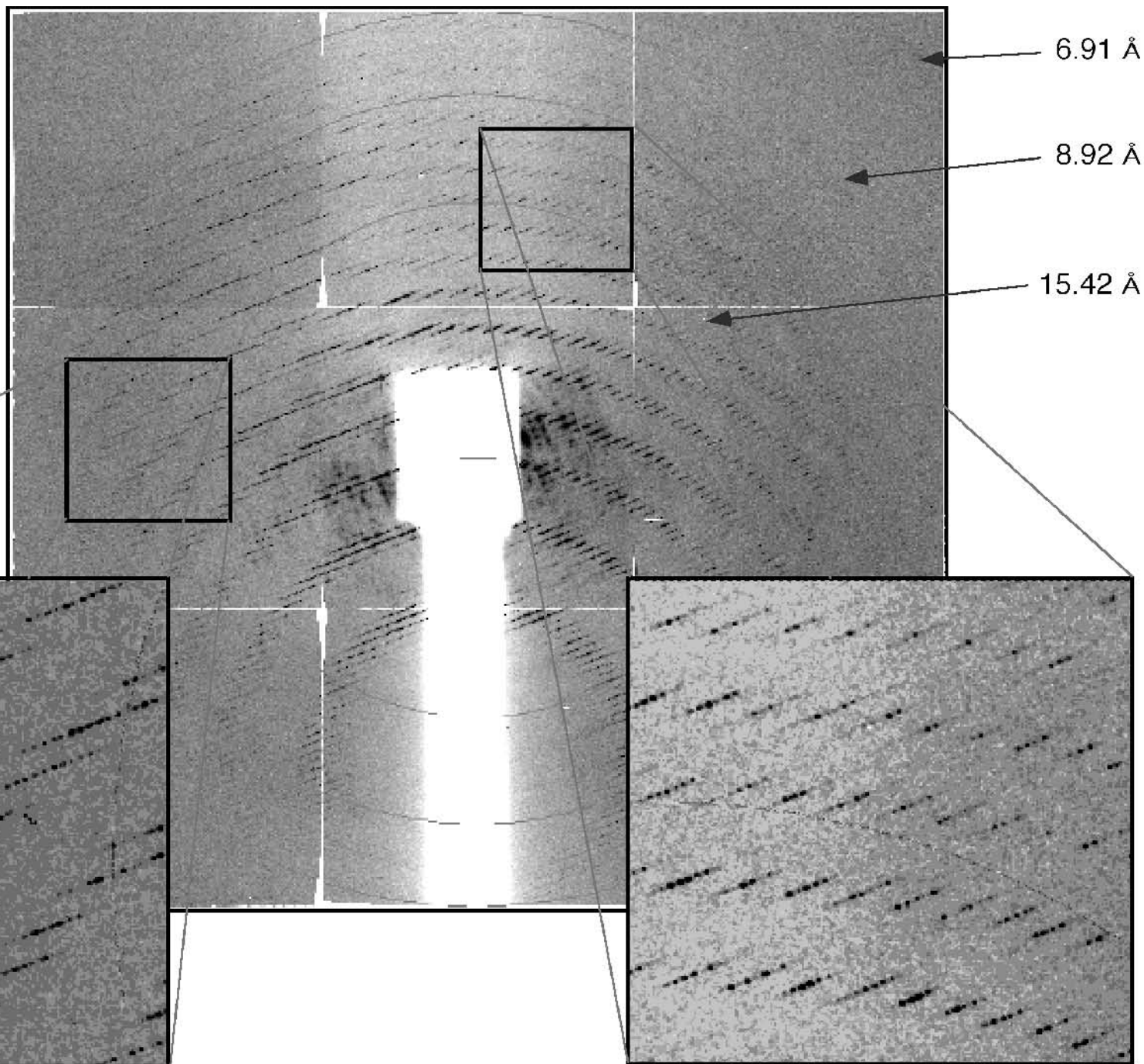
Mapping Binding of Antibiotics to Ribosomal Subunits

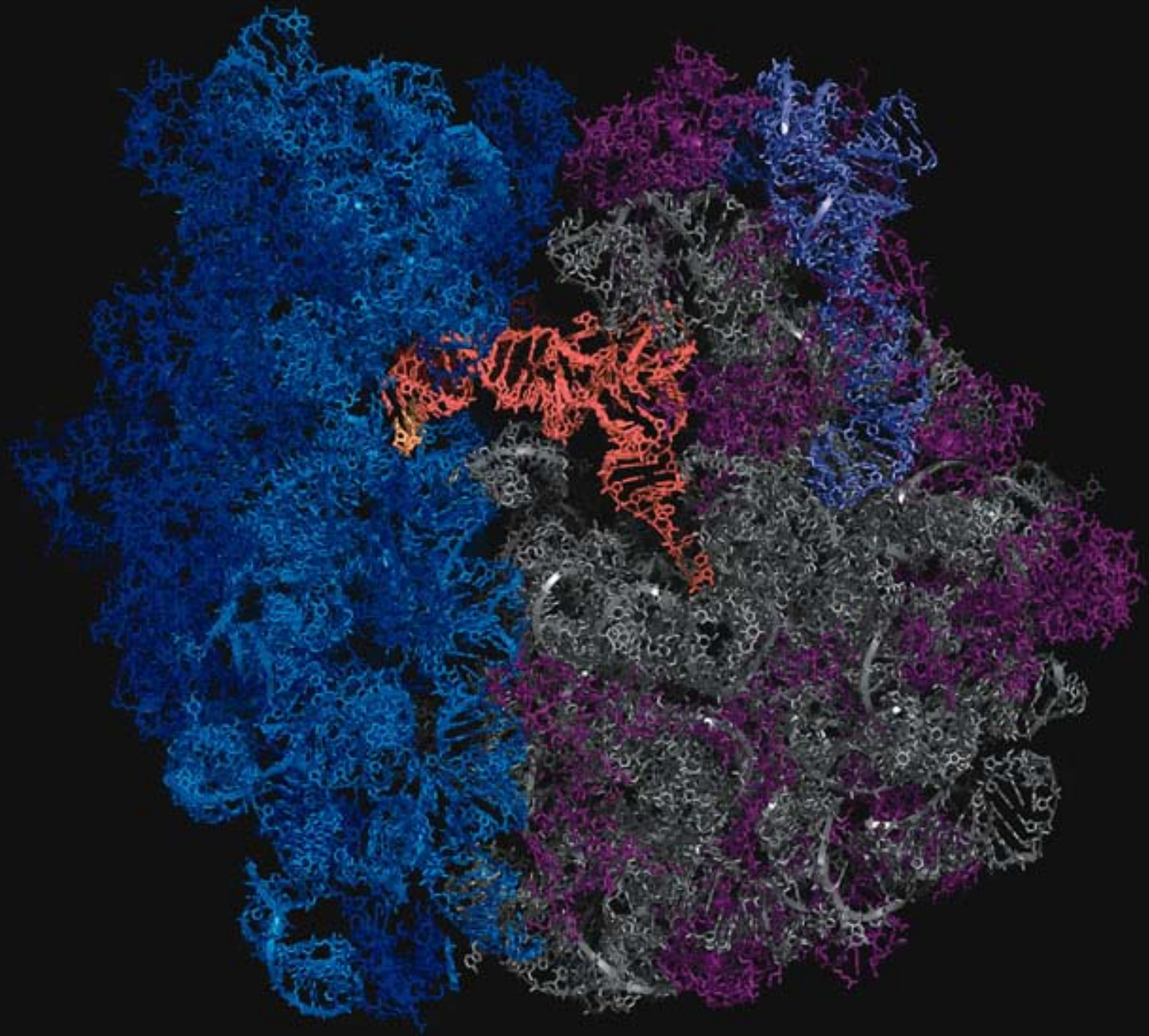


Mapping Binding of Antibiotics to Ribosomal Subunits

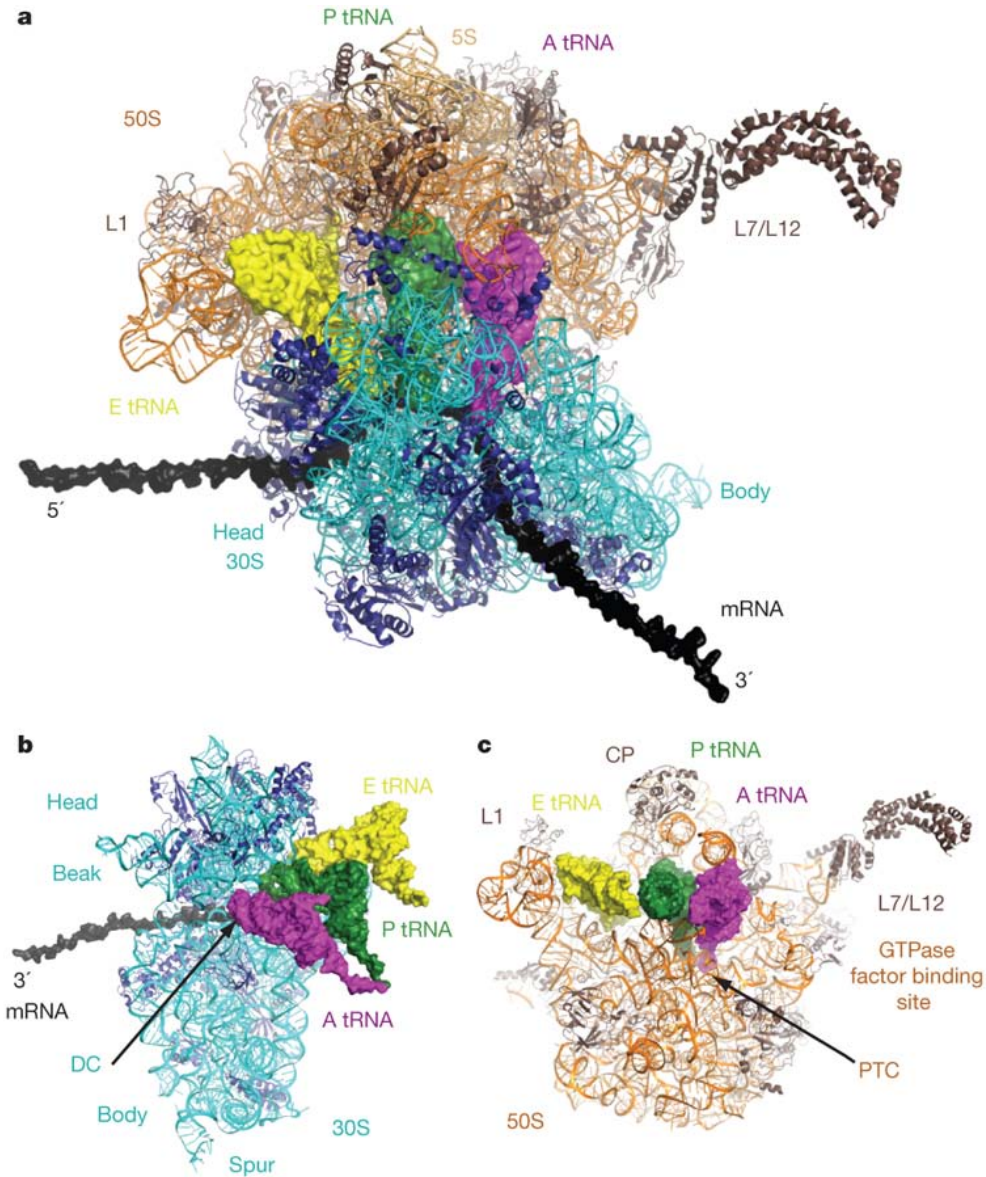


Diffraction pattern obtained at the SBC 19ID beamline from complete ribosomal particles (10 – 12 MDa per asymmetric unit). The crystallographic unit cell is centered, with 2700 Å as the longest axial length. (Courtesy of Dr. Jaime Cate, University of California Berkeley).

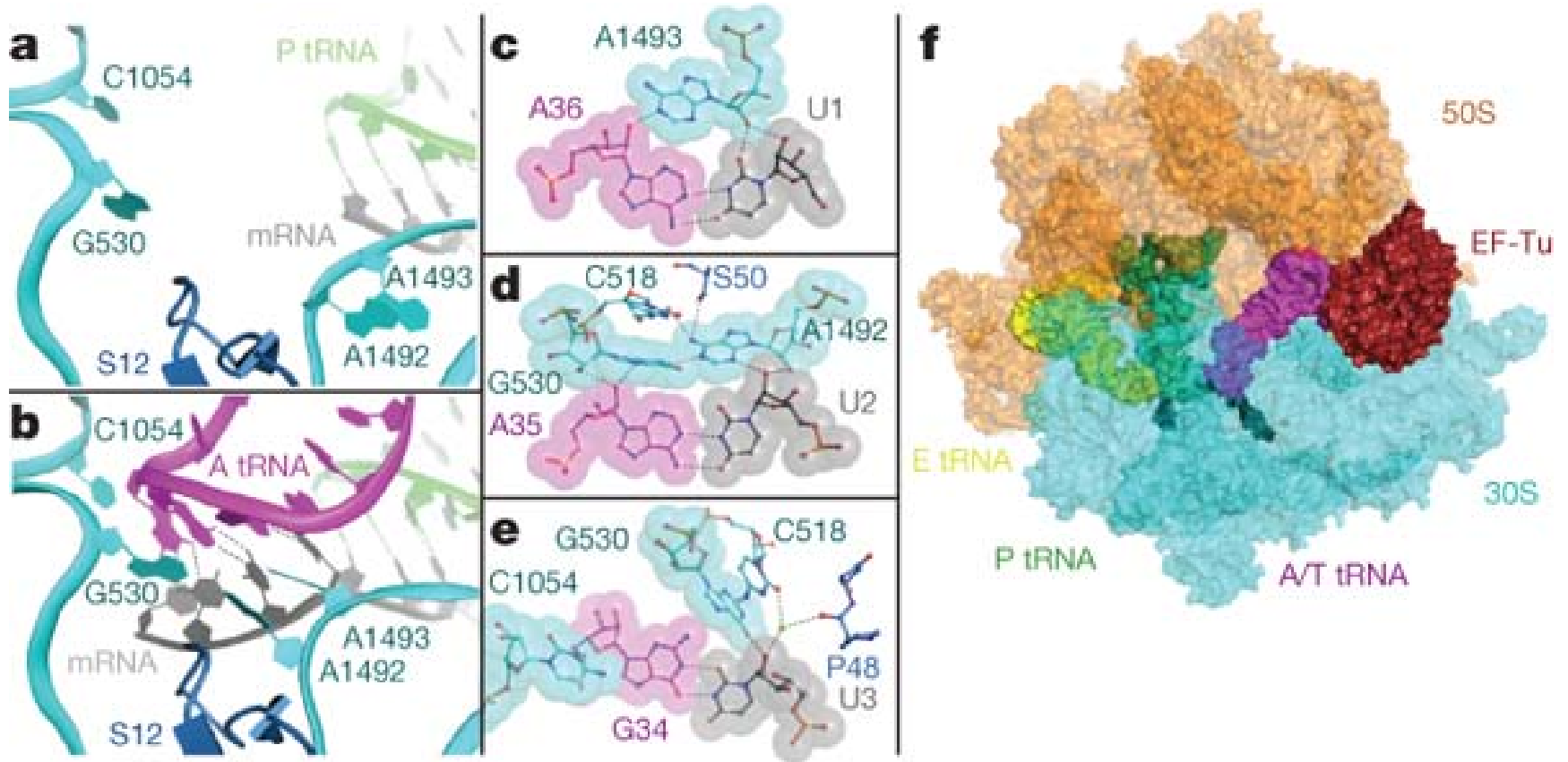




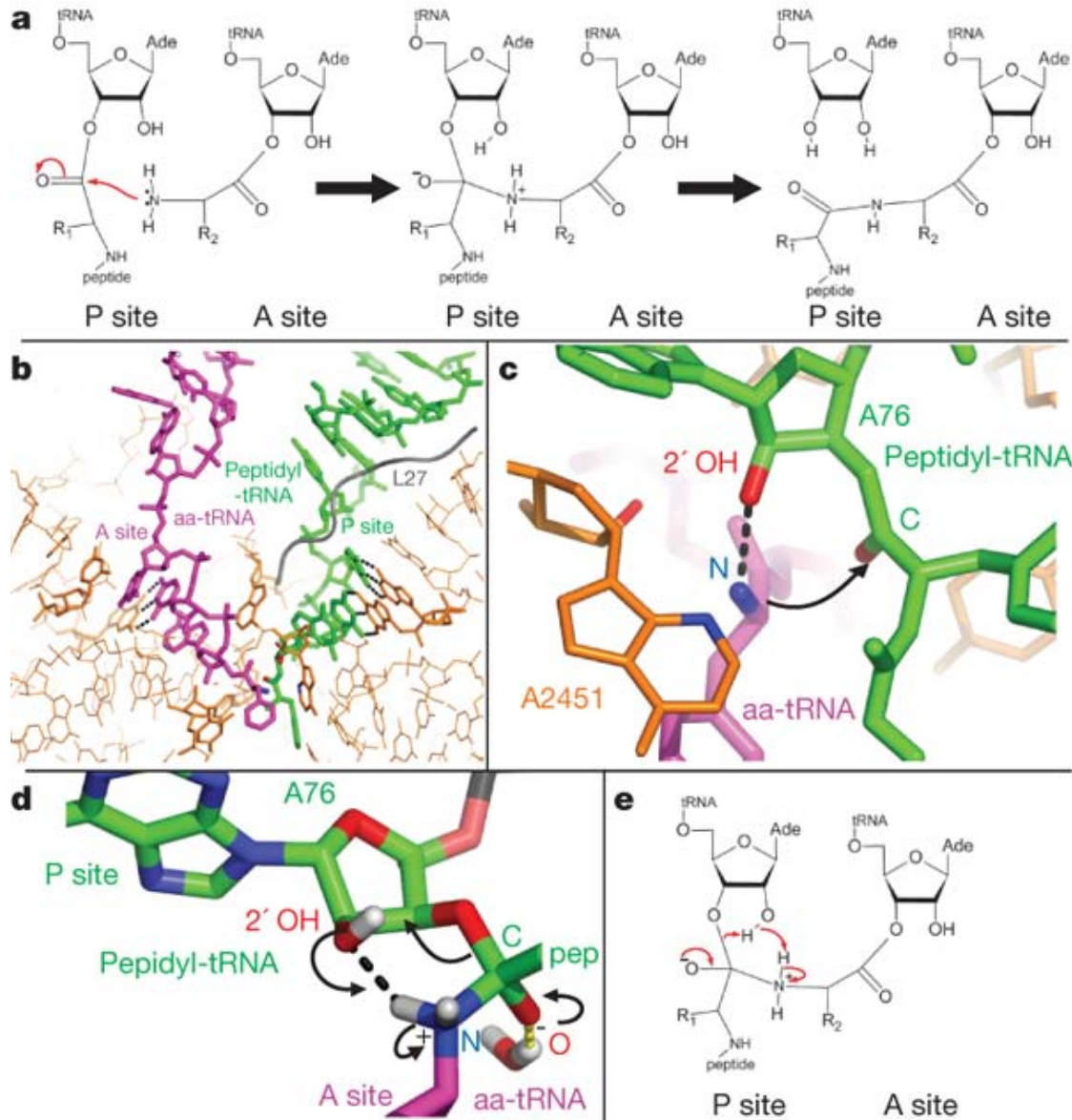
Structure of the Ribosome



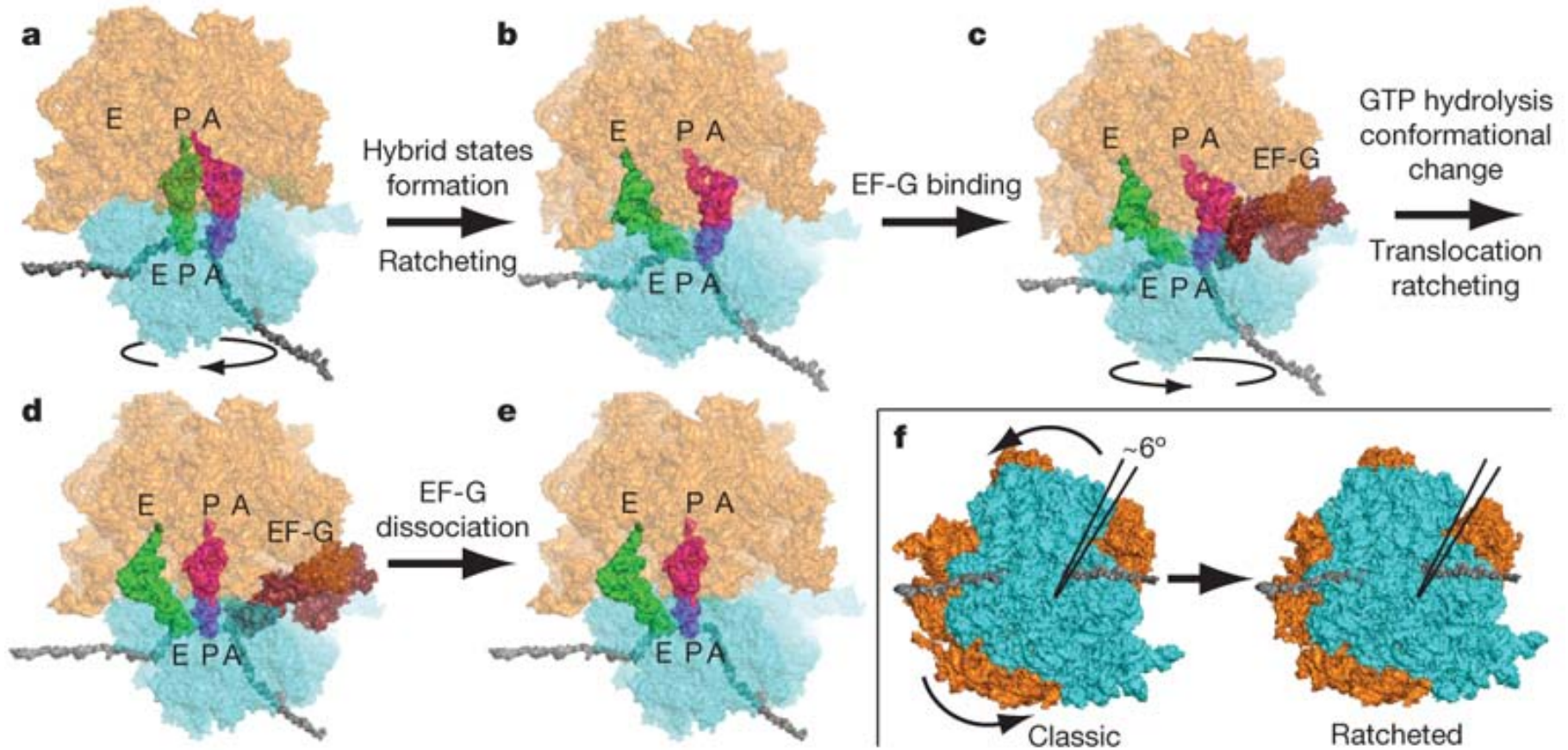
Decoding by the Ribosome



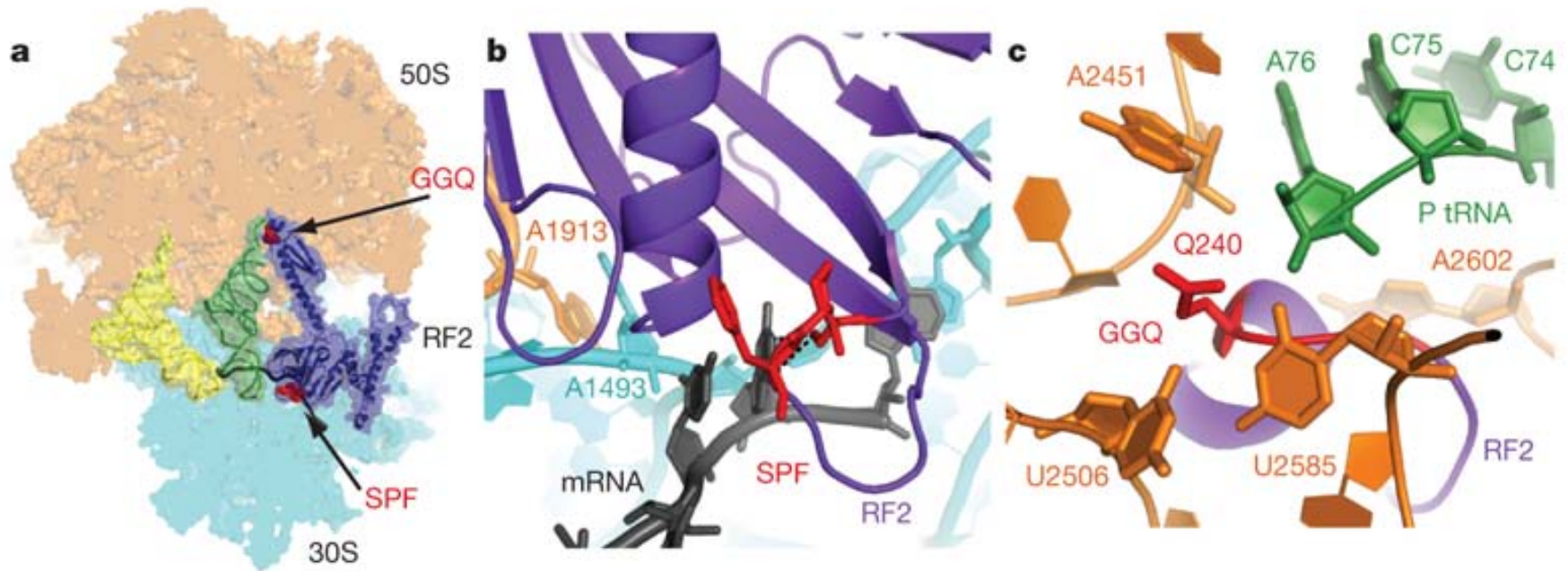
Peptide Bond Formation



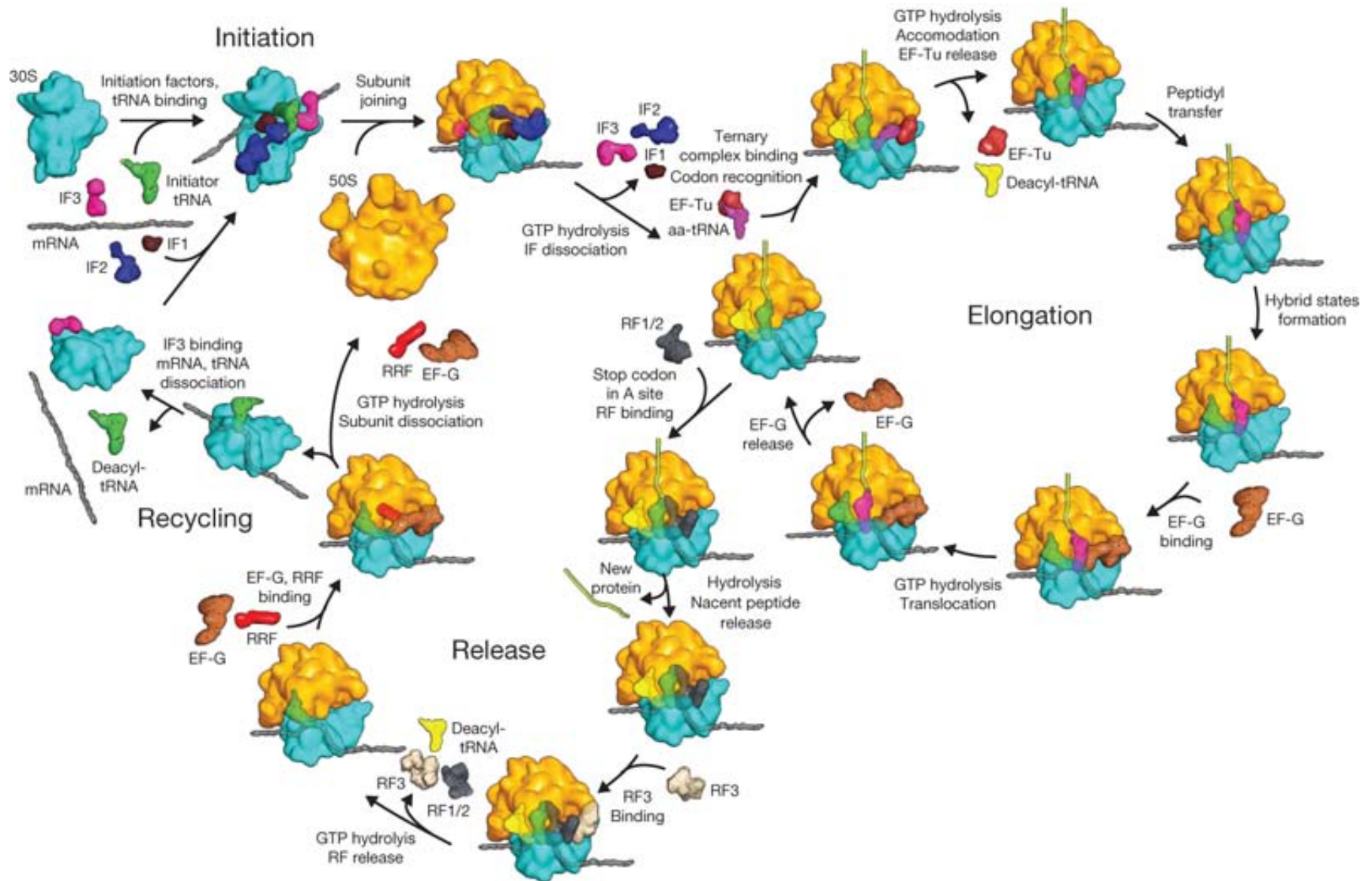
Translocation



Translation Termination



Overview of Bacterial Translation



“It's important to realize that support for basic science is the seed that allows the medical applications and technology to grow”

Venkatraman Ramakrishnan



Covers from SBC for work on ribosomes

