



A guideline for 3D printing of macromolecular models on the cheap



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1. Macromolecular models are needed for teaching and demonstration

The models should be:

Based on real scientific data;

Depicted using standardized representations;

Easy to edit and adapt to the outcomes of a specific lesson;

Cheap to fabricate and reproduce;

Easy to distribute

3D Printing

2. Steps involved when fabricating a macromolecular model

Download structure from PDB or CIF file

Visualize and prepare the model in UCSF Chimera

STL file

Prepare the file for printing using Ultimaker Cura

GCODE file

Print

Support material removal

Clean up and finalize the physical model

1. Chose or combine **visualization styles**;
2. Add **H bonds** or **create struts** to make the model more sturdy (mandatory for cartoon and balls and sticks models, not required for surface);
3. Increase the **thickness** of each printed element and/or **improve the smoothness** for molecular surfaces.

A. Generate the computer model

1. Set the printing scale;
2. Orient the model on printing bed;
3. Set printing resolution;
4. Set shell wall thickness and infill %;
5. Automatically add support;
6. Slice the model;
7. Send the resulting gcode to printer (via SD-Card, USB or WiFi)

B. Print the model

C. Clean up and finalize the physical model

3. Examples of printed models

Figure 1. Main components a bovine mitochondrial ATP synthase

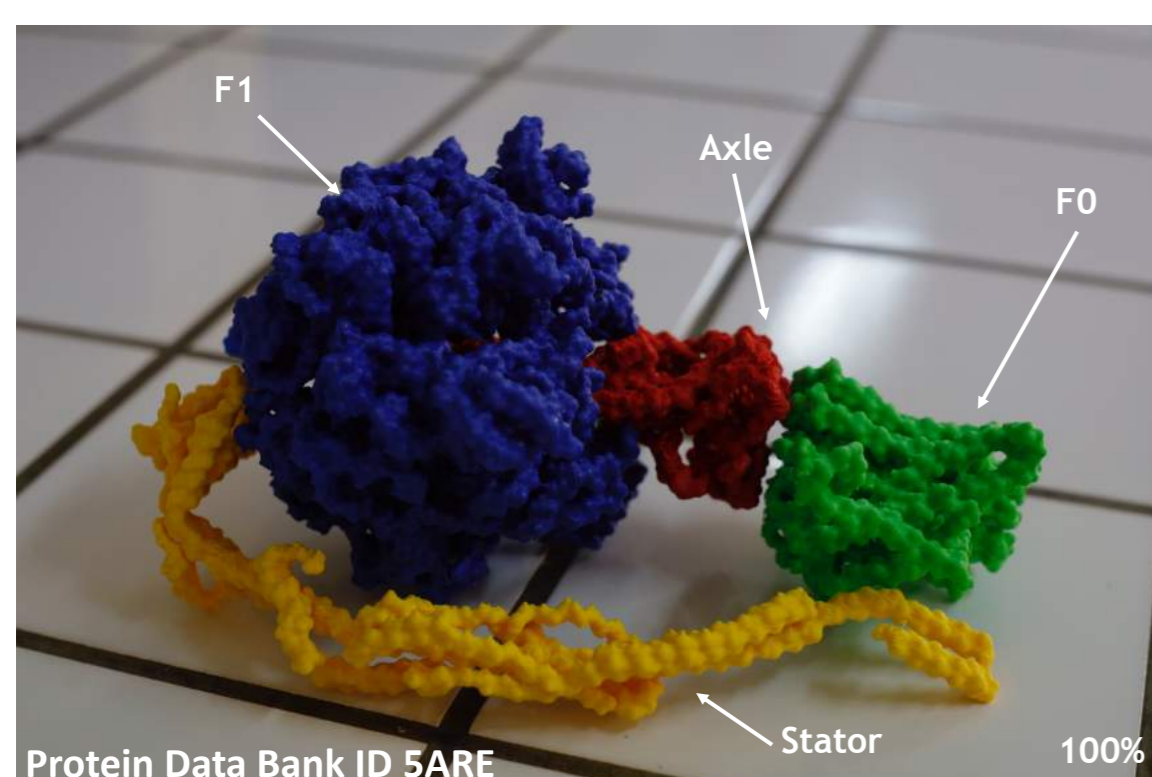


Figure 2. Antibodies interacting with an antigen

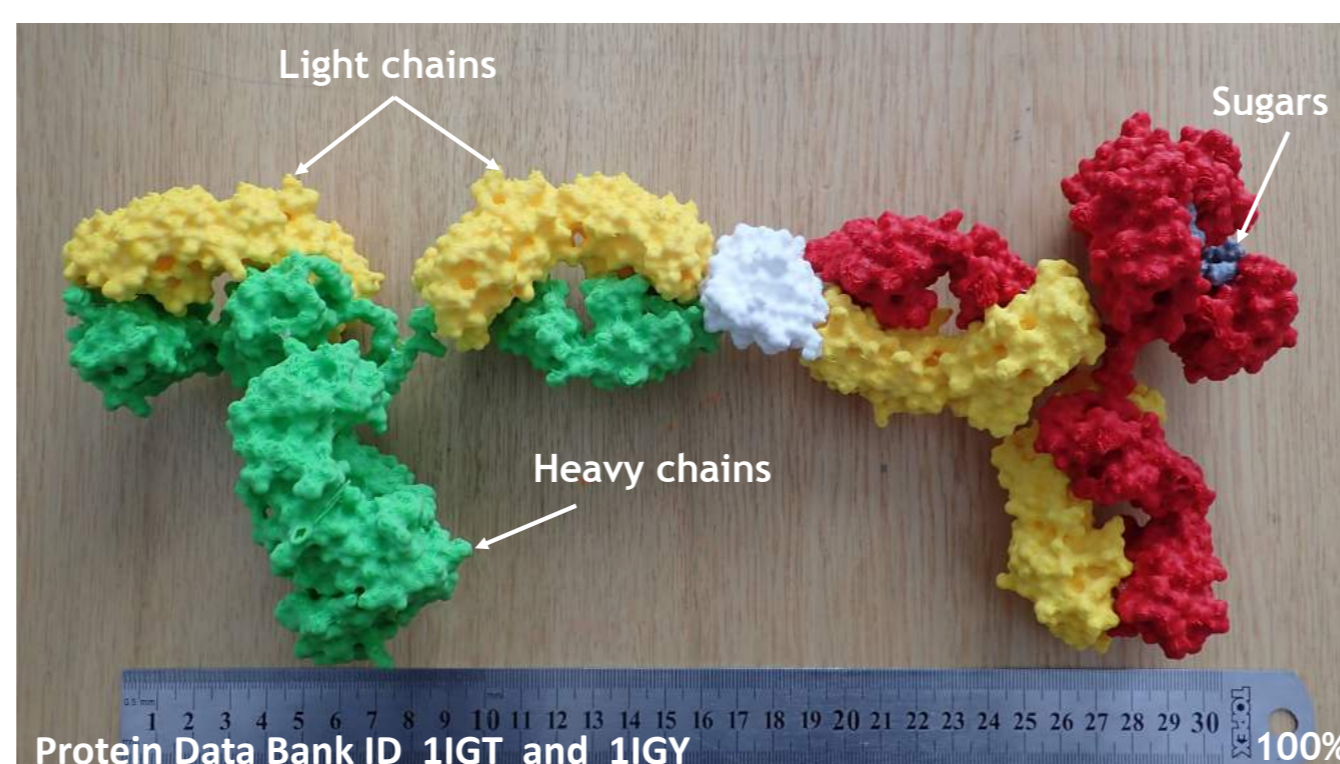


Figure 3. Proteins reading DNA sequence

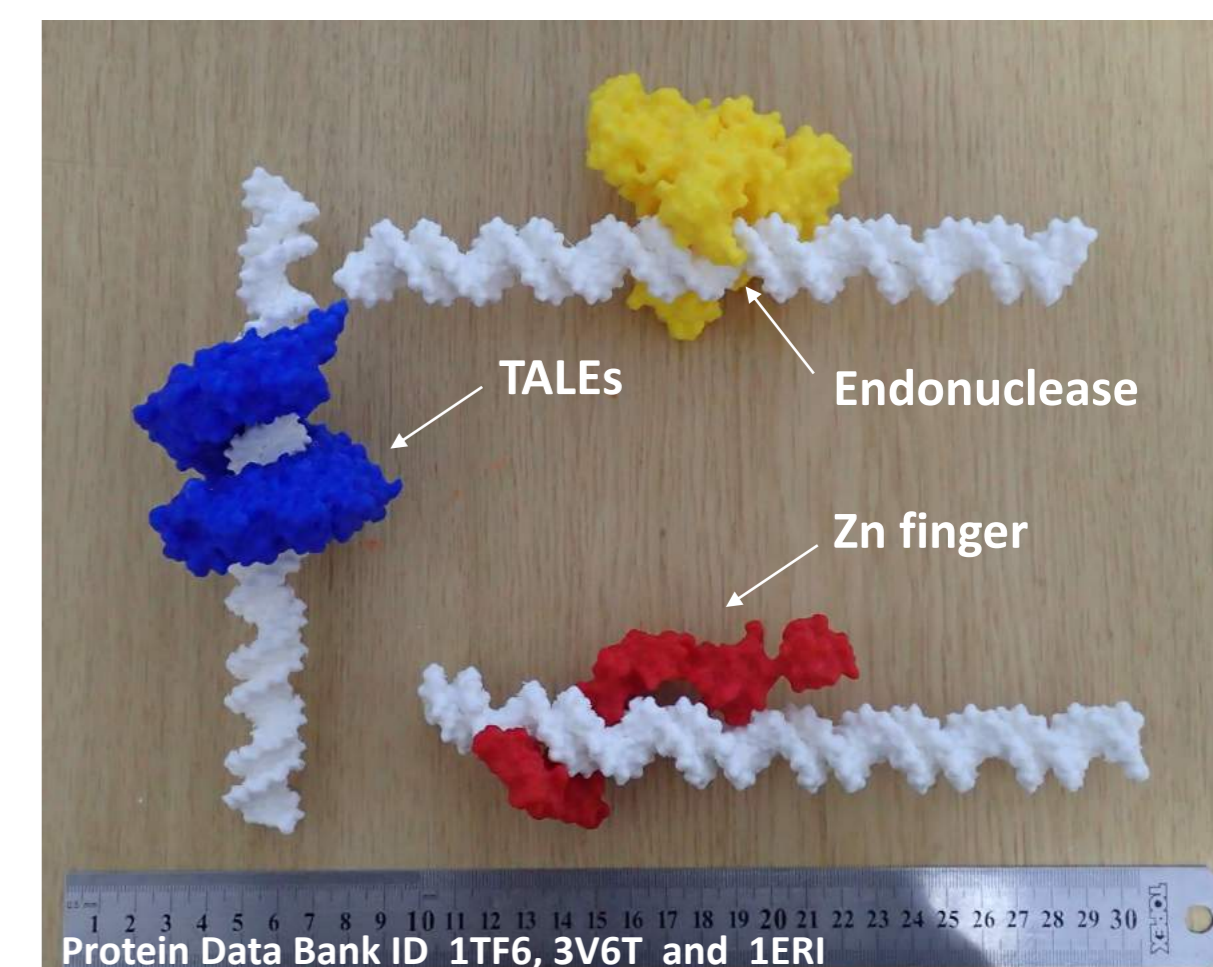
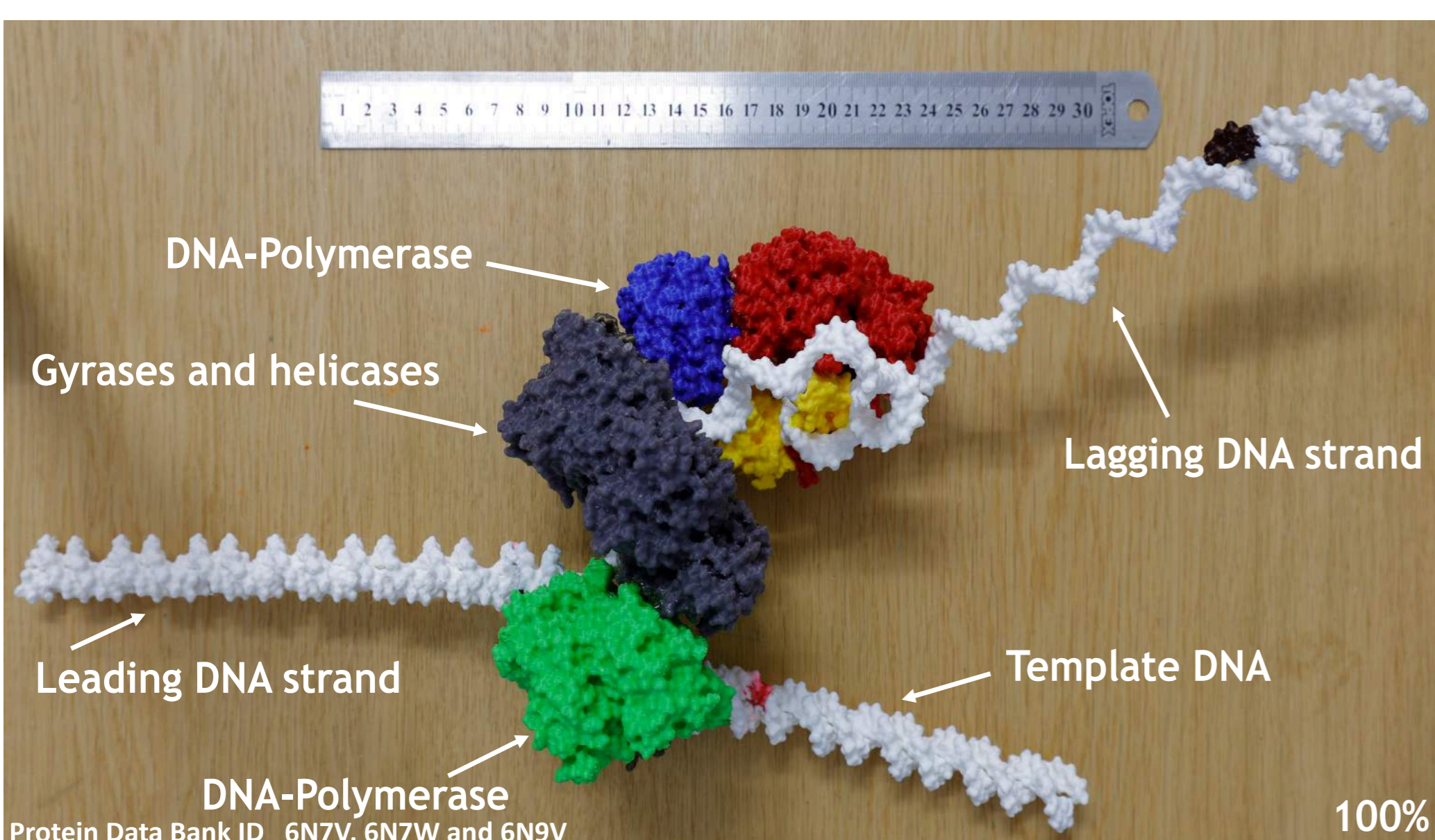


Figure 4. Physical model of a DNA replication fork



4. The "real" guide complete with technical details :

<https://doi.org/10.1002/bmb.21493>

All models presented here, including printing instructions available for download at: <https://3dprint.nih.gov/users/mariusmihasan/model>



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